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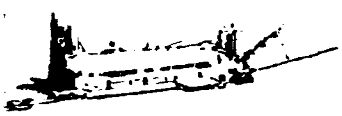

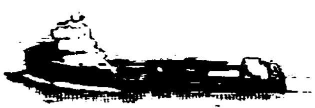

(2)

DREDGING RESEARCH PROGRAM

TECHNICAL REPORT DRP-92-6

ADCIRC: AN ADVANCED THREE-DIMENSIONAL CIRCULATION MODEL FOR SHELVES, COASTS, AND ESTUARIES

Report 2

USER'S MANUAL FOR ADCIRC-2DDI

by

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U.S. Army Corps of Engineers Waterways Experiment Station
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January 1994
Report 2 of a Series

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under Work Unit No. 32466

The Dredging Research Program (DRP) is a seven-year program of the US Army Corps of Engineers. DRP research is managed in these five technical areas:

Area 1 - Analysis of Dredged Material Placed in Open Waters

Area 2 - Material Properties Related to Navigation and Dredging

Area 3 - Dredge Plant Equipment and Systems Processes

Area 4 - Vessel Positioning, Survey Controls, and Dredge Monitoring Systems

Area 5 - Management of Dredging Projects

US Army Corps
of Engineers
Waterways Experiment
Station

Dredging Research Program
Report Summary

ADCIRC: An Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries; Report 2, User's Manual for ADCIRC-2DDI (TR DRP-92-6)

ISSUE: A unified and systematic methodology must be provided to use in the investigation of the dispersive or nondispersive characteristics of a site proposed for the disposal of dredged material in open water as well as to analyze existing disposal sites.

RESEARCH: ADCIRC (Advanced Three-Dimensional Circulation Model) was developed as a part of the Dredging Research Program (DRP) as a means of generating a database of harmonic constituents for tidal elevation and current at discrete locations along the east, west, and Gulf of Mexico coasts and to utilize tropical and extratropical global boundary conditions to compute frequency-indexed storm surge hydrographs along the U.S. coasts. The database is being developed to provide site-specific hydrodynamic boundary conditions for use in analyzing the long-term stability of existing or proposed dredged material disposal sites.

SUMMARY: The report describes the theory, methodology, and verification of the finite element numerical model ADCIRC. The model was developed to produce long numerical simulations on the order of a year for very large computational domains: for example, the entire east coast of the United States. The model was designed for high computational efficiency and was tested extensively for both hydrodynamic accuracy and numerical stability . Results of the tests are included in the report.

AVAILABILITY OF REPORT: The report is available through the Interlibrary Loan Service from the US Army Engineer Waterways Experiment Station (WES) Library, telephone number (601) 634-2355. National Technical Information Service (NTIS) report numbers may be requested from WES Librarians.

To purchase a copy of the report, call NTIS at (703) 487-4780.

About the Authors: Dr. Norman W. Scheffner, Coastal Processes Branch of the Coastal Engineering Research Center's Research Division at the U.S. Army Engineer Waterways Experiment Station, was the Principal Investigator for the DRP work unit. Dr. R. A. Luettich, Jr., Institute of Marine Sciences, University of North Carolina at Chapel Hill, and Dr. J. J. Westerink and Ms. C. A. Blain, Department of Civil Engineering and Geological Sciences, University of Notre Dame, assisted Dr. Scheffner in developing the modeling goals, concepts, and methodologies. Drs. Luettich and Westerink completed development and implementation of the model. For further information about the DRP, contact Mr. E. Clark McNair, Jr., Manager, DRP, at (601) 634-2070.

Dredging Research Program

Technical Report DRP-92-6
January 1994

ADCIRC: An Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries

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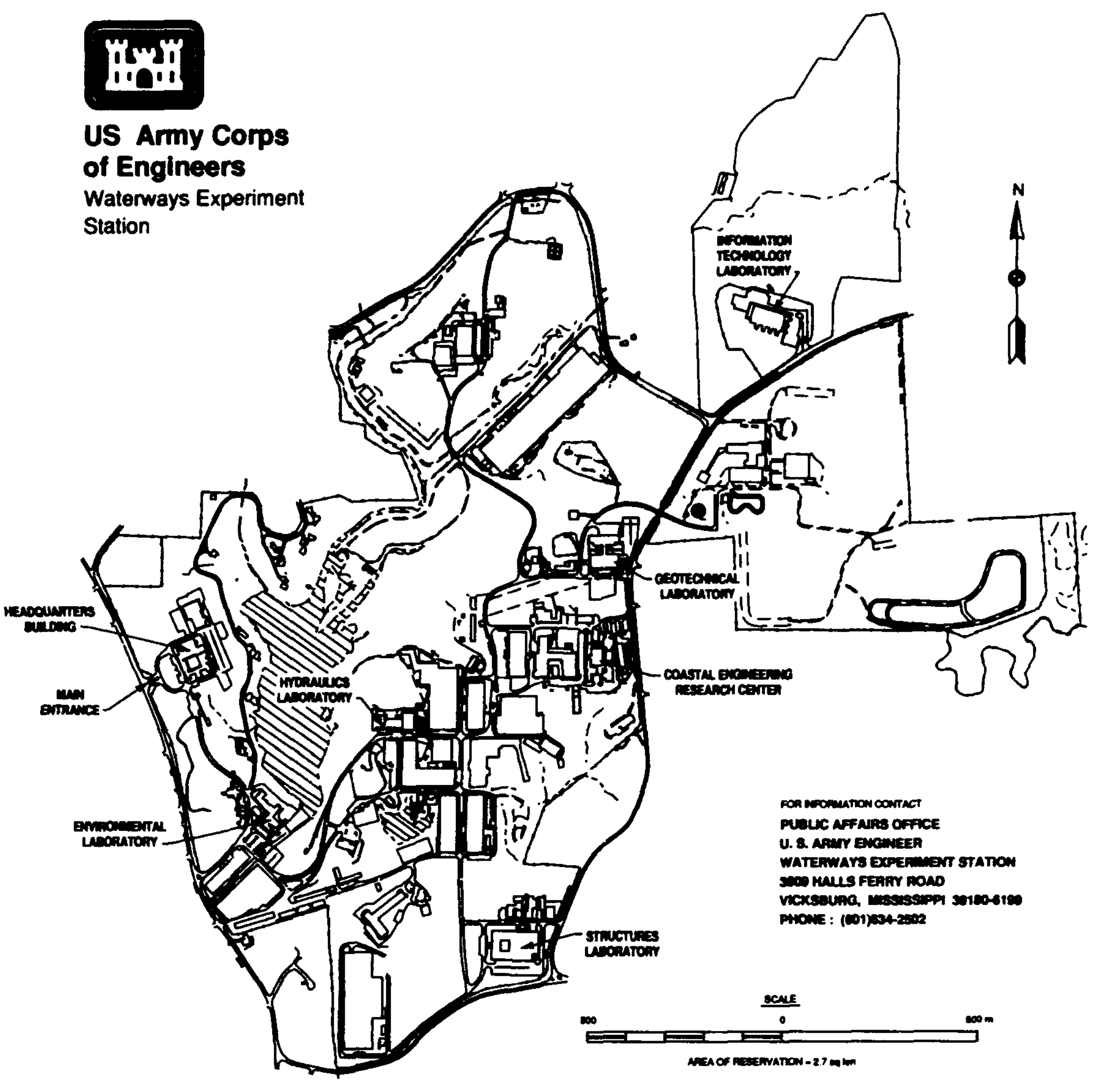
Waterways Experiment Station



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Preface

The work described in this report was authorized and funded under Work Unit No. 32466, "Numerical Simulation Techniques for Evaluating Long-Term Fate and Stability of Dredged Material Disposed in Open Water," of Technical Area 1 (TA1), Analysis of Dredged Material Placed in Open Water, of the Dredging Research Program (DRP). The project was sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE). Messrs. Robert Campbell and Glenn Drummond were DRP Chief and TA1 Technical Monitor from HQUSACE, respectively. Mr. E. Clark McNair, Jr., (CERC), U.S. Army Engineer Waterways Experiment Station (WES), was DRP Program Manager (PM) and Dr. Lyndell Z. Hales, Coastal Engineering Research Center (CERC) was Assistant PM. Dr. Nicholas C. Kraus, Research Division (RD), CERC, was the Technical Manager of DRP TA1 and Dr. Norman W. Scheffner, Coastal Processes Branch (CPB), RD, CERC, was the Principal Investigator of Work Unit No. 32466. The numerical modeling goals, concepts, and methodologies were developed by Dr. Scheffner, Dr. Joannes J. Westerink and Ms. C. A. Blain, University of Notre Dame and Dr. Richard A. Luettich, Jr., University of North Carolina. Development and implementation of the model were completed by Drs. Westerink and Luettich.

This study was performed and the report prepared over the period of 19 July 1988 through 15 July 1992. Dr. Scheffner was under the administrative supervision of Dr. James R. Houston, Director, CERC; Mr. Charles C. Calhoun, Jr., Assistant Director, CERC; Mr. H. Lee Butler, Chief, RD, CERC; and Mr. Bruce A. Ebersole, Chief, CPB, RD, CERC.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Additional information can be obtained from Mr. E. Clark McNair, Jr., Program Manager, at (601) 634-2070 or Dr. Norman W. Scheffner, Principal Investigator, at (601) 634-3220.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degrees	0.01745329	radians
feet	0.3048	meters

Summary

This report describes the use of model ADCIRC-2DDI, a two-dimensional, depth-integrated, finite-element-based hydrodynamic circulation code. ADCIRC-2DDI solves the shallow-water equations in their full nonlinear form and includes the nonlinear convective terms, the finite amplitude terms as well as the standard quadratic parameterization of the bottom friction terms, in addition to a spatially variable eddy viscosity term. ADCIRC-2DDI can be forced with elevation boundary conditions, zero normal boundary fluxes, variable spatial and temporal free surface stress and atmospheric pressure forcing functions in addition to Coriolis and tidal potential forcing terms.

The algorithms that comprise ADCIRC-2DDI allow for extremely flexible spatial discretizations which results in a highly effective minimization of the discrete size of any problem. Furthermore, these algorithms show good stability characteristics, generate no spurious artificial modes, have no inherent artificial damping, efficiently separate the partial differential equations into small systems of algebraic equations with time independent matrices and have been coded in fully vectorizable form. The resulting model can be applied to computational domains encompassing the deep ocean, continental shelves, coastal seas and small-scale estuarine systems. Furthermore, the model is able to efficiently run months to years of simulation while providing detailed intratidal response characteristics.

A complete description of all user aspects is given in this document, including the setup of input files, the output files, and the use of a preprocessor which sets up the code for a specific application and machine. Both model-specific and general modeling practices are discussed. Finally, two examples are presented. Sample input and output files are presented in Appendices A and B.

1 Introduction

This report describes the use of ADCIRC-2DDI, the two-dimensional depth-integrated component of the ADCIRC (Advanced Circulation Model) system of two- and three-dimensional hydrodynamic finite-element-based codes. The goal in the development of the ADCIRC system of codes has been to bring together and develop state-of-the-art algorithms that are highly flexible, accurate and extremely efficient. The algorithms that comprise ADCIRC allow for extremely flexible spatial discretizations resulting in a highly effective minimization of the discrete size of any problem. Furthermore, these algorithms show good stability characteristics, generate no spurious artificial modes, have no inherent artificial damping, efficiently separate the partial differential equations into small systems of algebraic equations with time-independent matrices, and have been coded in fully vectorizable form. The resulting model can be applied to computational domains encompassing the deep ocean, continental shelves, coastal seas, and small-scale estuarine systems. Furthermore, the model is able to run months to years of simulation while providing detailed intratidal response characteristics.

ADCIRC-2DDI is formulated using the highly successful Generalized Wave-Continuity Equation formulation (Lynch and Gray 1979; Kinnmark 1984; Luettich, Westerink, and Scheffner 1992). ADCIRC-2DDI solves for the shallow-water equations in their full nonlinear form and includes nonlinear convective acceleration terms and finite amplitude terms as well as the standard quadratic parameterization of bottom friction terms. In addition a spatially variable eddy viscosity term is included. The ADCIRC-2DDI model (version 24.16) can be forced with elevation boundary conditions, zero normal boundary fluxes, variable spatial and temporal free surface stress and atmospheric pressure forcing functions in addition to Coriolis and tidal potential forcing terms. A complete description of the governing equations, numerical formulation, and implementation for ADCIRC-2DDI is given by Luettich, Westerink,and Scheffner (1992). The main feature of version 24.16 not described by Luettich, Westerink, and Scheffner (1992) is the formulation of the model in both Cartesian and spherical coordinates, which is described by Kolar, Gray, Westerink, and Luettich (in preparation) and also briefly described in this document. Furthermore, the eddy viscosity terms are now treated explicitly in the momentum equations. It is recommended that users carefully review Luettich, Westerink, and Schneffer (1992) as well as this document prior to applying ADCIRC-2DDI.

This report describes the details of using ADCIRC-2DDI. In Chapter 2, a brief overview of the governing equations as well as the numerical discretization techniques used in formulating ADCIRC-2DDI are presented. In Chapter 3, the use of a preprocessor that modifies ADCIRC-2DDI for a specific application and computer is discussed. In Chapter 4, the necessary input files and their structure are described. Guidelines for selecting variables are also given. In Chapter 5, the output files generated by ADCIRC-2DDI are discussed. In Chapter 6, the simpler quarter annular test case is presented and discussed. Finally, in Chapter 7, a detailed application to the Gulf of Mexico is presented. Sample input and output files for Examples 1 and 2 are presented in Appendices A and B, respectively.

2 Summary of the Governing Equations and Numerical Discretization

The depth-integrated equations of mass and momentum conservation, subject to the incompressibility, Boussinesq, and hydrostatic pressure approximations, are the basis for ADCIRC-2DDI. Using the standard quadratic parameterization for bottom stress, approximating the combined turbulent diffusion and momentum dispersion effects with a simplified eddy viscosity model, as well as neglecting baroclinic terms leads to the following set of conservation statements in primitive non-conservative form for a Cartesian coordinate system:

$$\frac{\partial \zeta}{\partial t} + \frac{\partial UH}{\partial x} + \frac{\partial VH}{\partial y} = 0 \tag{1}$$

$$\begin{aligned} &\frac{\partial U}{\partial t} + U \frac{\partial U}{\partial x} + V \frac{\partial U}{\partial y} - fv = \\ &- \frac{\partial}{\partial x} \left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta) \right] + \frac{1}{H} M_x + \frac{\tau_{sx}}{\rho_0 H} - \tau_* U \end{aligned} \tag{2}$$

$$\frac{\partial V}{\partial t} + U\frac{\partial V}{\partial x} + V\frac{\partial V}{\partial y} + fU =$$

$$- \frac{\partial}{\partial y}\left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta)\right] + \frac{1}{H}M_y + \frac{\tau_{sy}}{\rho_0 H} - \tau_* V \tag{3}$$

where

ζ = free surface elevation relative to the geoid

U, V = depth-averaged horizontal velocities

$H = \zeta + h$ = total water column

h = bathymetric depth relative to the geoid

$f = 2\Omega sin\phi$ = Coriolis parameter

Ω = angular speed of the Earth

ϕ = degrees latitude

p_s = atmospheric pressure at the free surface

g = acceleration due to gravity

η = Newtonian equilibrium tide potential

a = effective Earth elasticity factor

ρ_0 = reference density of water

τ_{sx}, τ_{sy} = applied free surface stress

$\tau_* = C_f \frac{(U^2 + V^2)^{1/2}}{H}$

C_f = bottom friction coefficient

The horizontal diffusion/dispersion model used in ADCIRC follows that of Kolar and Gray (1990) and is computed as:

$$M_x = E_{h_2}\left[\frac{\partial^2 UH}{\partial x^2} + \frac{\partial^2 UH}{\partial y^2}\right]$$ = depth-integrated horizontal diffusion/dispersion

$$M_y = E_{h_2}\left[\frac{\partial^2 VH}{\partial x^2} + \frac{\partial^2 VH}{\partial y^2}\right]$$ = depth-integrated horizontal diffusion/dispersion

E_{h_2} = horizontal eddy diffusion/dispersion coefficient

A practical expression for the Newtonian equilibrium tide potential is given by Reid (1990) as:

$$\eta(\lambda, \phi, t) = \sum_{n,j} C_{jn} f_{jn}^{TP} (t_o)\ L_j\ (\phi) \cos\left[2\pi(t - t_0)/T_{jn}^{TP} + v_{jn}^{TP} (t_0)\right] \qquad (4)$$

where

C_{jn} = constant characterizing the amplitude of tidal constituent n of species j

f_{jn}^{TP} = time-dependent nodal factor

v_{jn}^{TP} = time-dependent astronomical argument

j = 0, 1, 2 = tidal species (j = 0, declinational; j = 1, diurnal; j = 2, semidiurnal)

$L_0 = 3\sin^2 \phi - 1$

$L_1 = \sin (2\phi)$

$L_2 = \cos^2 (\phi)$

λ,ϕ = degree longitude and latitude, respectively

t_0 = reference time

T_{jn}^{TP} = period of constituent n of species j

Values for C_{jn} are presented in Luettich, Westerink, and Schneffer (1992) and values for f_{jn}^{TP} and v_{jn}^{TP} can be computed from tables (e.g., Schureman 1941) or by using available harmonic analysis packages (e.g., Foreman (1977)). It should be noted that the value for the effective Earth elasticity factor is

typically taken as 0.690 for all tidal constituents. However, its value has been shown to be constituent-dependent (Wahr 1981).

ADCIRC-2DDI solves for the governing equations in spherical form as well as in Cartesian form. In spherical coordinates, the primitive shallow-water equations are as follows:

$$\frac{\partial \zeta}{\partial t} + \frac{1}{R \cos \phi}\left(\frac{\partial UH}{\partial \lambda} + \frac{\partial \, (VH\cos \phi\,)}{\partial \phi}\right) = 0 \tag{5}$$

$$\begin{aligned} &\frac{\partial U}{\partial t} + \frac{1}{R \cos \phi} U \frac{\partial U}{\partial \lambda} + \frac{1}{R} V \frac{\partial U}{\partial \phi} - \left(\frac{\tan \phi}{R} U + f\right) = \\ &- \frac{1}{R \cos \phi}\frac{\partial}{\partial \lambda}\left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta)\right] + \frac{1}{H}(M_\lambda\,) + \frac{\tau_{s\lambda}}{\rho_0 H} - \tau_* U \end{aligned} \tag{6}$$

$$\begin{aligned} &\frac{\partial V}{\partial t} + \frac{1}{R \cos \phi} U \frac{\partial V}{\partial \lambda} + \frac{1}{R} V \frac{\partial V}{\partial \phi} + \left(\frac{\tan \phi}{R} U + f\right) U = \\ &- \frac{1}{R}\frac{\partial}{\partial \phi}\left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta)\right] + \frac{1}{H} M_\phi + \frac{\tau_{s\phi}}{\rho_0 H} - \tau_* V \end{aligned} \tag{7}$$

ADCIRC-2DDI solves these spherical equations by first mapping them into a rectilinear coordinate system using a Carte Parallelogrammatique Projection (CPP) (Pearson 1990). The projected form of the spherical equations is very similar to the Cartesian form with the exception of additional spatially dependent factors in various terms.

ADCIRC-2DDI does not solve the shallow-water equations in primitive form but is based on the generalized wave continuity equation (FWCE) form of the sallow-water equations. Primitive shallow-water equation models using the finite element (FE) method are plagued with severe spurious mode problems and typically require the heavy-handed use of non-physical dissipation, limiting their usefulness as predictive tools) (Gray 1982). However, the GWCE formulations of Lynch and Gray (1979) and Kinnmark (1984) lead to FE depth-integrated coastal circulation codes that are highly accurate and robust. Thorough testing (Lynch and Gray 1979; Lynch 1981; Walters 1983, 1984; Drolet 1989), extensive analysis (Platzman 1981, Foreman 1983, Lynch 1983, Drolet and Gray 1988) and detailed field applications (Werner and

Lynch 1987; Walters 1987; Walters 1988; Werner and Lynch 1989; Walters and Werner 1989; Gray, Drolet, and Kinnmark 1987; Gray 1989; Lynch and Werner 1991; Lynch et al. 1988, 1990; Foreman 1988; Westerink and Gray 1991) during the past decade have documented the behavior of GWCE-based FE models and have demonstrated their unique advantages in terms of concurrently achieving a high level of computational accuracy and efficiency.

The GWCE is derived by combining a time-differentiated form of the primitive continuity equation and a spatially differentiated form of the primitive conservation of momentum equations, reformulating the convective terms into non-conservative form, adding the primitive form of the continuity equation multiplied by a constant in time and space τ_0 and rearranging the eddy viscosity terms (Lynch and Gray 1979; Kinnmark 1984; Kolar and Gray 1990; Luettich, Westerink, and Schneffer 1992). The GWCE equation for Cartesian coordinates is expressed as:

$$
\begin{aligned}
&\frac{\partial^2 \zeta}{\partial t^2} + \tau_0 \frac{\partial \zeta}{\partial t} + \frac{\partial}{\partial x}\left\{ U \frac{\partial \zeta}{\partial t} - UH \frac{\partial U}{\partial x} - VH \frac{\partial U}{\partial x} + fVH \right. \\
&\left. - H \frac{\partial}{\partial x}\left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta) \right] - E_{h_2} \frac{\partial^2 \zeta}{\partial x \partial t} + \frac{\tau_{sx}}{\rho_0} - (\tau_* - \tau_0) UH \right\} \\
&+ \frac{\partial}{\partial y}\left\{ V \frac{\partial \zeta}{\partial t} - UH \frac{\partial V}{\partial x} - VH \frac{\partial V}{\partial y} - fUH - H \frac{\partial}{\partial y}\left[\frac{p_s}{\rho_0} + g(\zeta - \alpha\eta) \right] \right. \\
&\left. \qquad - E_{h_2} \frac{\partial^2 \zeta}{\partial y \partial t} + \frac{\tau_{sy}}{\rho_0} - (\tau_* - \tau_0) VH \right\} = 0
\end{aligned}
\tag{8}
$$

The GWCE is solved in conjunction with the primitive form of the momentum equations, Equations 2 and 3.

The numerical discretization of the GWCE and momentum equations has been implemented using strategies similar to Werner and Lynch (1987) and Kolar and Gray (1990) and is described in detail by Luettich, Westerink, and Schneffer (1992). The discretization procedure is implemented in three well-defined stages. First, symmetrical weak weighted residual statements are developed for the GWCE and primitive momentum equations. The resulting equations require C_o functional continuity. Second, the equations are time discretized. A variably weighed three-time-level implicit scheme is used for most linear terms in the GWCE with the nonlinear, Coriolis, atmospheric

pressure forcing, and tidal potential terms being treated explicitly. The time derivative term that appears in the non-conservative convective terms in the GWCE is evaluated at two known time levels. A Crank-Nicolson two-time-level implicit discretization is applied to all the terms in the momentum equations with the exception of the τ_* terms, the convective terms, and the eddy viscosity terms, which are treated explicitly. Finally, the FE method is implemented. This involves expanding the variables over C_0 three-node linear triangles (with the exception of the non-spatially differentiated portion of the convective term in the final weighted residual form of both the GWCE and the momentum equations, which apply L_2 interpolating functions), developing discrete equations on an elemental level, assembling global systems of equations, and enforcing elevation boundary conditions in the discrete GWCE and normal velocity boundary conditions in the discrete momentum equations. It should be noted that the discrete GWCE is decoupled from the discrete momentum equations, allowing a sequential solution procedure. Furthermore, the GWCE system matrix is time independent and only needs to be assembled and decomposed once for a direct solver. Mass lumping is implemented for the momentum equations. Therefore, even though the discrete momentum equations system matrix is time dependent, it is trivial to solve since it is diagonal. Finally, ADCIRC-2DDI has also been highly vectorized. The features described make ADCIRC-2DDI highly efficient in terms of central processing unit (CPU) requirements per node.

3 Program ADCSETUP, a Preprocessor for ADCIRC-2DDI

Program ADCSETUP is an interactive preprocessor which sets up a production version of the ADCIRC-2DDI FORTRAN source code that is specific to the problem and computer on which ADCIRC-2DDI will run. Prior to running ADCSETUP, the user must have available the initial ADCIRC-2DDI source code file, in addition to the two standard input files (UNIT 14 and UNIT 15 files described in Chapter 4 of this report).

ADCSETUP is run interactively and the user is prompted to enter the following information:

- The name of the initial ADCIRC-2DDI FORTRAN source code file.

- The name of the modified ADCIRC-2DDI FORTRAN source code file, which is specific to the problem and computer on which ADCIRC-2DDI will be run.

- The name of the UNIT 14 input file required by ADCIRC-2DDI. This is the grid input file.

- The name of the UNIT 15 input file required by ADCIRC-2DDI. This input file specifies most parameters needed for the simulation.

- The type of computer on which ADCIRC-2DDI will be run. Specifically, whether the code will be run on a scalar or vector machine. If the user indicates that the code will be run on a scalar computer, the user is prompted to indicate whether the scalar machine is a SUN computer or other than a SUN computer.

- The user is then questioned whether ADCIRC-2DDI will be run on a 32-bit computer (e.g., SUN, CONVEX, IBM RS 6000 etc.) or a 64-bit computer (e.g., CRAY YMP, DEC ALPHA computers).

- The user is finally asked whether the non-vectorizable portions of the code should be optimized for memory or for speed. The ADCIRC-2DDI code has been set up such that memory requirements are minimized but at the cost of an increase in the number of required operations or vice versa. If memory is readily available on the computer on which the simulation is to be run, the code should be optimized for speed.

ADCSETUP uses the information provided interactively by the user in addition to the information in the UNIT 14 and UNIT 15 input files to tailor the production version of ADCIRC-2DDI source code for the given problem being solved and the computer being used. Specifically the following modifications are made:

- All dimension statements in the main code as well as subroutines are set to the minimum values required to run the problem described by the UNIT 14 and 15 input files.

- All dimension statements are set for a 32- or 64-bit processor as required for specific computer.

- The code is set up to use either a banded matrix solver from the LINPACK library (Dongarra et al. 1979) of subroutines or an interactive compact storage mode type matrix solver from the ITPACK 2D library or subroutines (Kincaid, Oppe, and Young 1989) as specified by the UNIT 15 input file. It is noted that the iterative solvers are substantially more efficient in terms of memory requirements, especially for large problems.

- Certain machine-specific calls are also set. For example, for SUN computers, an ABRUPT UNDERFLOW call is set.

- The code is optimized for either vector or scalar implementation.

- Non-vector portions of the code are optimized for either speed or memory. The speed optimization relies on storing pre-computed coefficients, which are used repeatedly during the time-stepping process.

After ADCSETUP has run and output a production version of the ADCIRC-2DDI FORTRAN source code that is specific to the problem/computer this production source code must be compiled and linked. The production source code should be compiled with the highest level of optimization the FORTRAN compiler will allow. If a direct banded matrix solver is specified in the UNIT 15 input file, the ADCIRC-2DDI production source code should be linked to the LINPACK package of subroutines (Dongarra et al. 1979). If any of the iterative solvers are specified in the UNIT 15 input file, the production source code should be linked to the ITPACKV 2D package of subroutines (Kincaid, Oppe, and Young 1989).

4 Input File Description

There are two standard and four supplemental input files. The two standard input files consist of UNIT 14 and UNIT 15. These input files must always be supplied in order for ADCIRC-2DDI to run. They are defined as "fort.14" and "fort.15" (lower case), respectively, by ADCIRC. UNIT 14 is the finite element grid file, which describes the triangular finite element grid, bathymetry, and boundaries. UNIT 15 is the input file, which defines the majority of input parameters necessary for running the code. The supplemental input files are activated by input parameters specified in UNIT 15 input and consist of files defined as UNITS 21, 22, 67, or 68. UNIT 21 (defined as "fort.21" by ADCIRC) contains spatially variable nodal friction and eddy viscosity values specified at the nodes. This file is only read in when NWP is specified equal to 1 in the input file UNIT 15. UNIT 22 (defined as "fort.22" by ADCIRC) contains wind stress and barometric pressure information and is read in only when NWS is specified equal to 1 in the input file UNIT 15. UNITS 67 and 68 (defined as "fort.67" and "fort.68" by ADCIRC) represent binary hot start files 1 and 2. The creation of these files is detailed in the section on the Description of the Input Variables Read in from UNIT 15. One of these files is used to restart an interrupted run. The use of these files to restart a run is described in the section on the Description of Input/Output Files UNITS 67 and 68. These files are activated as input files and read in by ADCIRC only when the UNIT 15 input parameter IHOT is designated as either 67 or 68.

Description of the Input Variables Read in from UNIT 14

The following input variables are required for UNIT 14 (defined as "fort.14" by ADCIRC). In general, free format is assumed unless otherwise noted.

AGRID = An alphanumeric grid identification up to 24 characters in length.

NE, NP = The number of finite elements in the grid and the number of nodal points in the grid, respectively.

JKI, X(JKI), Y(JKI), DP(JKI); JKI=1,NP = The node numbers, nodal coordinates, and bathymetry at the nodes. The nodes must be input in sequential order. In addition, the way in which the input coordinates are specified depends on how the UNIT 15 input parameter ICS is specified (see details on ICS in the section on the description of the input variables read in from UNIT 15). If ICS is specified equal to 1 in the UNIT 15 input file, the governing equations solved by ADCIRC are in standard Cartesian form. In this case, the X and Y coordinates are specified in units of length consistent with the specified value of G (gravity specified in UNIT 15 input) and the bathymetric values at the nodes. Typically the units for X, Y, and DP are either meters or feet. The depth DP is defined relative to the geoid. If ICS is specified equal to 2 in the UNIT 15 input, the governing equations used by ADCIRC are based on a CPP form of the spherical coordinate from the shallow-water equations. In this case, the X and Y coordinates are specified in degrees longitude (degrees east of the Greenwich meridian being positive and degrees west of the Greenwich meridian being negative) and degrees latitude (degrees north of the equator being positive and degrees south of the equator being negative). It should be noted that the CPP transformation applied converts both the equations and the coordinates into a CPP rectilinear coordinate system with length units in meters. Therefore, G (gravity specified in UNIT 15) must be specified in meters per square second. Furthermore, bathymetry, which is defined relative to the geoid, must be specified in meters. Regardless of the coordinate system being used, the discretization must provide at least 30 nodes per wavelength. All significant waves must be resolved and therefore the frequency content of the response should be carefully examined (Westerink, Stolzenbach, and Connor 1989). Thus the shortest significant wave should be discretized with at least 30 nodes. However, in many cases, a higher level of discretization must be provided (Westerink et al. 1992a,b), e.g., over steep topography, near intricate boundaries, and/or for complex atmospheric forcing functions.

JKI, NHY, NM(JKI,1), NM(JKI,2), NM(JKI,3); JKI=1,NE = The element number, element type, and element connectivity specified with a counterclockwise orientation. It is noted that the element type is not an active variable and that only 3-node linear triangles are operational in the release version of the code. Therefore element type is a dummy variable. Elements must be read in in sequential order.

NOPE = The number of open boundary forcing or elevation-specified boundary segments.

NETA = The total number of open boundary nodes.

NVDLL(K); K=1,NOPE = The number of nodes on open boundary forcing segment K. It is noted that NVDLL(K) precedes NBDV(K,I); I=1,NVDLL(K) for each of the K=1,NOPE segments.

NBDV(K,I); I=1,NVDLL(K) = The node numbers on open boundary forcing segment K for each of the K=1,NOPE segments. The direction in which this information is given does not matter. Again, NVDLL(K) is given first for each segment and is followed by the nodes on that segment.

NBOU = The number of land boundary or zero flux specified boundary segments.

NVEL = The total number of land boundary nodes.

NVELL(K), IBTYPE; K=1,NBOU = The number of nodes on land boundary segment K and the boundary type for segment K. For mainland boundaries (this includes island boundaries which are not included in their entirety), IBTYPE should be specified equal to 0 for a free-lateral-slip condition and equal to 10 for a no-lateral-slip condition. For island boundaries (the island must lie entirely within the domain and must not be a part of the exterior boundary of the domain), IBTYPE must be specified equal to 1 for a free-lateral-slip condition and equal to 11 for a no-lateral-slip condition. It is noted that NVELL(K) and IBTYPE for segment K precede NBVV(K,I); I=1,NVELL(K) for each of the K=1,NBOU segments. It is also noted that in general the free-lateral-slip conditions should be selected unless the application is small-scale and significant grid detail is provided throughout the region of interest ($\Delta x \leq 50$m). Furthermore, when no-lateral-slip conditions are specified, lateral eddy viscosity E_{h_2} should be specified as nonzero (see UNIT 15 input).

NBVV(K,I); I=1,NVELL(K) = The node numbers on land boundary segment K for each of the K=1,NBOU segments. The direction in which the nodes are specified should be such that land is on the right-hand side. Thus mainland boundaries (all IBTYPE=0 boundaries) are specified in a counterclockwise direction and island boundaries are specified in a clockwise direction. Island boundary nodes are specified such that the boundary is left unclosed (i.e., each node on the island boundary is specified only once). Again, NVELL(K) is given first for each segment and this is followed by the nodes on that segment.

Description of the Input Variables Read in from UNIT 15

The following input variables required for UNIT 15 (defined as "fort.15" by ADCIRC). In general, free format is assumed unless otherwise noted.

RUNID = A 24-character alphanumeric run description that enables the user to identify runs.

RUNDES = A 32-character alphanumeric run description that enables the user to identify runs.

NFOVER = A non-fatal error override option. When NFOVER is set equal to 1, all checked input variables that are inconsistent will, in most cases, be automatically corrected to a default or corrected value and execution will continue. The user must be sure to read the nonfatal warning messages to see what the program has done. If NFOVER is specified not equal to 1, all checked input parameters that are inconsistent will lead to program termination. Note that NFOVER does not affect any fatal warning checks, which will always stop execution. Furthermore, all non-fatal run time error checks are treated in the same manner as input variable checks.

NABOUT = A parameter to activate abbreviated output to UNIT 16. If NABOUT=1, then the output to UNIT 16 will be abbreviated by not echo printing most of the UNIT 14, 21, and 22 input information. If NABOUT is not specified equal to 1, almost all of the information from all of the input files will be echo printed to UNIT 16.

NSCREEN = A parameter that controls whether output is directed to the screen (UNIT 6) for simulations run interactively or a UNIT 6 file for simulations run as batch jobs.

If NSCREEN = 0, UNIT 6 output will not be provided.

If NSCREEN = 1, UNIT 6 output will be provided. Information spooled to UNIT 6 includes limited run time information, warnings (these are also provided in UNIT 16 output) as well as the time-step and the maximum elevation and velocity values within the computational domain and the corresponding node numbers at which these occur.

IHOT = A parameter that controls whether the model is hot started. When starting a new run, no hot-start procedure is used. However, if the run is abruptly terminated due to the computer going down, the user can restart the simulation at a point prior to the abrupt termination by restarting the run using one of the two hot-start files. The hot-start files are generated by setting parameters NHSTAR and NHSINC in the UNIT 15 input files. Two hot-start files are written in order to ensure that at least one complex hot-start file exists in case the computer goes down while a hot-start file is being written. A run is hot started using the *most recently completed* hot-start file, either fort.67 or fort.68. The hot-start files contain all the information required to restart the run at the point at which the most recently completed hot-start file was written.

IHOT = 0, the model is cold started.

IHOT = 67, the model is hot started using input read from UNIT 67 (fort.67).

IHOT = 68, the model is hot started using input read from UNIT 68 (fort.68).

ICS = A parameter that determines in which coordinate system the calculations are performed.

If ICS = 1, the standard Cartesian form of the governing equations is used in the model. Input coordinates are in standard length units (as determined by the units of gravity, G). If NTIP=1 and /or NCOR=1, then an inverse Carte Parallelogrammatique Projection (CPP) is used in order to obtain the coordinates for the nodes in degrees longitude and latitude so that variable Coriolis and/or tidal potential forcing functions can be computed. It is noted that in this case (ICS=1, NTIP=1, and /or NCOR=1), the specified Cartesian coordinate system must line up with the local meridians and parallels. However, in general, the authors recommend that when NTIP=1 and/or NCOR=1, the spherical coordinate system should be used (i.e., ICS=2) since when the Coriolis parameter significantly varies over the domain and/or tidal potential forcing is significant, the domain is large enough to warrant the use of governing equations in spherical form.

If ICS = 2, the governing equations are based on the spherical equations transformed using a CPP projection. The input coordinates are specified in degrees longitude and latitude and are then also transformed using the CPP projection. Since the CPP transformation is based on meters, G must always be specified in meters per square second.

IM = A parameter that indicates the treatment for the vertical dimension.

If IM = 0, the vertically integrated equations are solved.

If IM ≠ 0, a variety of three-dimensional solution strategies solve for the vertical structure of the currents and couple to the depth-integrated solution using an internal/external mode strategy. These options are not active for the two-dimensional release version of the code (24.16). However, the three-dimensional release version of ADCIRC will be able to run both in depth-integrated mode as well as using various vertical solution strategies. Furthermore, the three-dimensional release version will retain an identical input structure for UNITS 14, 15, 21, 22, 67, and 68. Therefore, the parameter IM has been included in the two-dimensional input structure of ADCIRC.

NOLIBF = A model option parameter that determines whether bottom stress is applied as a linear relationship or using the standard nonlinear quadratic parameterization.

If NOLIHBF = 0, the bottom friction term is linearized such that τ_* is a constant that is not functionally dependent on velocity.

If NOLIBF = 1, the standard quadratic parameterization for bottom friction is used such that:

$$\tau_* = \frac{C_f \, (U^2 + V^2)^{1/2}}{H} \tag{9}$$

NOLIFA = A model option parameter that determines whether the finite amplitude component of the total depth is considered.

If NOLIFA = 0, finite terms in the equations are not included. Thus, the full depth $H = h + \zeta$ is approximately the depth to the geoid h.

If NOLIFA = 1, finite-amplitude terms in the equations are included. Thus, the full depth $H = h + \zeta$ is used in all terms where it appears. It is noted that when the finite amplitude terms are turned on, the time derivative portion of the convective acceleration terms should also be included in the computations for reasons of consistency and mass conservation (i.e., when NOLIFA equals 1, NOLICAT should also be set equal to 1).

NOLICA = A model option parameter that determines whether the convective acceleration terms (with the exception of the time derivative portion of the convective terms in the GWCE) are included in the computations.

If NOLICA = 0, convective acceleration terms containing spatial derivatives are not included in the computations.

If NOLICA = 1, convective acceleration terms containing spatial derivatives are included in the computations. It is noted that when the spatial derivative portions of the convective terms are turned on, the time derivative portions of the convective acceleration terms should also be included in the computations for reasons of consistency and mass conservation (i.e., when NOLICA equals 1, NOLICAT should also be set equal to 1).

NOLICAT = A model option parameter that determines whether the time derivative components of the convective acceleration terms in the GWCE are included in the computations. These terms should be turned

on if the finite amplitude terms and/or the spatial derivative portion of the convective terms are considered in the computations for reasons of solution consistency and mass conservation.

If NOLICAT = 0, the time derivative components of the convective acceleration terms in the GWCE are not included.

If NOLICAT = 1, the time derivative components of the convective acceleration terms in the GWCE are included.

NWP = A variable that determines whether the nonlinear bottom friction coefficient C_f and the lateral viscosity coefficient E_{h_2} are specified as spatially homogeneous or nonhomogeneous.

NWP = 0 for spatially homogeneous nonlinear bottom friction and lateral viscosity coefficients (i.e., one value is used for each coefficient throughout the computational domain).

NWP = 1 for spatially varying nonlinear bottom friction and lateral viscosity values. In this case the nonlinear bottom friction and lateral viscosity values are specified at each node in a UNIT 21 file. Therefore UNIT 21 must be provided.

There are no provisions to specify a nonhomogeneous linearized bottom friction coefficient. The linearized bottom friction coefficient is used when NOLIBF equals 0 and is always constant throughout the entire domain.

NCOR = A variable that determines whether the Coriolis parameter $f = 2\Omega sin\phi$ is treated as a spatially homogeneous or variable parameter.

NCOR = 0 when the Coriolis parameter is specified as spatially homogeneous. This option should typically be used when ICS=1.

NCOR = 1 when the Coriolis parameter is specified as spatially varying. This option should typically be used when ICS=2. Spatially varying Coriolis parameters are computed on a nodal basis as $f = 2\Omega sin\phi$ where Ω equals the angular speed of the Earth (specified within the code in radians per second) and ϕ equals degrees latitude at a node. For cases in which ICS=1, the ϕ values are based on an inverse CPP projection. For cases in which ICS=2, the ϕ values are obtained directly from the UNIT 14 input coordinates.

NTIP = A variable that determines the inclusion of the tidal potential forcing function within the domain. For large domains such as the Gulf of Mexico, the tidal potential functions for all the main constituents when a large domain is being studied. For small domains, tidal potential forcing will not be important.

NTIP = 0 when the tidal potential function is not used. This option should typically be used when ICS=1.

NTIP = 1 activates the tidal potential function η in the computations. η is given by Equation 4. This option should typically be used when ICS=2. For cases in which ICS=1, the ϕ and λ values necessary in the evaluation of η are based on an inverse CPP projection. For cases in which ICS=2, the ϕ and λ values are obtained directly from the UNIT 14 input coordinates. Other parameters required for the computation of the tidal potential function η are provided later in this input file.

NWS = A variable that determines whether wind stress and surface pressure forcing functions are applied.

NWS = 0 when no wind stress or surface pressure fields are specified.

NWS = 1 when spatially varying wind stress and surface pressure fields are applied. In this case, a UNIT 22 file specifies the horizontal stress and atmospheric pressure fields.

NRAMP = A ramp option parameter.

If NRAMP = 0, no ramp function is applied to the forcing functions.

If NRAMP = 1, a hyperbolic tangent ramp function is applied to the surface elevation specified boundary conditions, the tidal potential forcing function, as well as the wind and atmospheric pressure forcing functions. This ramp function has the form:

$$RAMP = \tan h \left(\frac{2.0 \times IT \times DT}{24.0 \times 3600 \times DRAMP} \right) \tag{10}$$

where *IT* equals current time-step, *DT* equals the time-step in seconds, and *DRAMP* is the specified number of days at which *RAMP* is approximately equal to 0.96. *DRAMP* is an input parameter specified later in this input file.

This ramp function helps avoid exciting resonant modes in large basins which may occur due to the cold start process. The ramp is effective over approximately *DRAMP* days (*RAMP* = 0 at the starting reference time (STATIM), *RAMP* = 0.96403 at *DRAMP* days after the starting reference time, *RAMP* = 0.99933 at 2*DRAMP* days after the starting reference time).

G = The gravitational constant. The code operates using seconds as the basic time unit. Some of the required input must be read in as hours or

days. However, this input is converted to seconds within the code after it is read in. G must be specified using seconds as the time unit. For the case when ICS=1, the specification of G does determine the length units with which the code operates. It is recommended that when using SI units, the basic length unit be meters; therefore, G would be specified as 9.81 m/s^2. When using English units, the basic length unit should be feet; therefore, G would be specified as 32.2 ft/s^2. For the case when ICS=2, G must always be specified in SI units as 9.81 due to the CPP transformation used. (A table of factors for converting non-SI units of measurement to SI (metric) units is provided on page ix).

TAUO = The generalized wave-continuity equation (GWCE) weighting factor. TAUO (denoted as τ_0 in Equation 8) weighs the primitive portion of the GWCE. Therefore when $\tau_0 = 0$, the GWCE will be a pure wave equation. When $\tau_0 >> 1$, the GWCE will be the primitive continuity equation. *It is very important that τ_0 be correctly specified in order to obtain good model performance.* If τ_0 is specified too small, mass leakage and consistency problems occur. If τ_0 is specified too large, stability requirements are more stringent, requiring smaller time-steps than with the correct τ_0. Furthermore, temporal and spatial oscillations may appear for very large τ_0. Based on extensive simulations on a broad range of test and field application problems, the authors recommend that $\tau_0 = (\tau_*)_{MAX}$ where $(\tau_*)_{MAX}$ represents the maximum value of τ_* throughout the domain and simulation. This estimate can be made on an order of magnitude basis, i.e., it does not have to be exact. However, the authors recommend that the estimate be on the high side, rather than on the low side. When the model is being run using the linearized bottom friction relationship (NOLIBF=0), simply select τ_0 to be equal to the specified value of τ_* (input as FFACTOR and processed as TAU). When the model applies the nonlinear bottom friction law (NOLIBF=1),

$$\tau_* = \frac{c_f\,(u^2 + v^2)^{1/2}}{h + \zeta} \tag{11}$$

Therefore, a high end estimate for $(\tau_*)_{MAX}$ may be obtained by using the specified bottom friction coefficient C_f (input as FFACTOR and processed CF), the maximum velocity, and the minimum total depth.

DT = The specified time-step in seconds (designated Δt in Luettich, Westerink, Scheffner (1992)). *The authors recommend that the maximum Courant number within the domain based on wave celerity not exceed 1.5.* The Courant number requirement is related to the explicit treatment of most of the nonlinear terms in the various equations. This criterion appears to lead to stable computations in almost all cases that the authors have worked with. For a linear simulation (i.e., NOLIBF=0, NOLIFA=0, NOLICA=0, and NOLICAT=0), there is no

Courant-based stability limit. However, it is still necessary to limit time-steps for accuracy considerations (the Courant value should not exceed about 1.5 for accuracy reasons as well; see Luettich, Westerink, and Scheffner (1992)).

The Courant number is computed as:

$$C_{\#} = \frac{(gh)^{1/2}\Delta t}{\Delta x} \tag{12}$$

The authors recommend that a pre-processor check the maximum Courant number to ensure that the time-step is properly selected. Over-discretizing in deep water will unnecessarily result in high Courant numbers in the deep water region. For a wave of period T, $C_{\#}$ can be related to the wavelength-to-grid size criterion as follows:

$$C_{\#} = \frac{\lambda}{\Delta x}\frac{\Delta t}{T} \tag{13}$$

Therefore, if $\lambda/\Delta x$ is unnecessarily high in deep water (this is often the case for regular grids), the Courant number will also be large there.

STATIM = The starting reference time is days. This defines the starting time for the simulation. The first time-step computes results for TIME=STATIM+DT (note that t = TIME, Δt = DT, and t_s = STATIM) and subsequent time-steps are computed at TIME=STATIM+IT*DT (where IT represents the number of time-steps taken). It is recommended that, in general, all times should be referenced to Greenwich Mean Time (GMT).

REFTIM = The reference time in days. This defines the reference time t_0 (used in both Equations 4 and 15), relative to which the nodal factors and equilibrium arguments for both the tidal potential forcing function and the boundary forcing function (f_{in}^{TP} and v_{in}^{TP} and f_i^{BF} and v_i^{BF}) are specified in the simulation. For computations that are non-time-frame specific and in which the equilibrium tides are directly simulated, REFTIM and STATIM should both be specified as zero and all nodal factors and equilibrium arguments should be specified as 1.0 and 0.0, respectively.

RNDAY = The total number of days of numerical simulation. Since the code uses a cold starting procedure, a number of days of spin-up time will be required prior to all start-up effects being fully dissipated and the system reaching a dynamic steady state. It is suggested that the

spin-up requirements be carefully examined prior to production runs (E.G., Westerink et al. (1992a)).

DRAMP = The number of days at which the RAMP function equals 0.96403. For more information see NRAMP in this input file.

A00, B00, C00 = The time weighting factors at time levels K+1, K, and K-1 in the GWCE equation. This allows the user to control the level of explicitness or implicitness of the GWCE equation. The authors recommend values of 0.35, 0.30, and 0.35, respectively.

H0 = The minimum bathymetric value. The code checks if depth at a given node is less than H0. If this is the case, then depth is reset to H0 at that node. This feature has been implemented in order to avoid drying of elements in the domain (since the current implementation of ADCIRC-2DDI does not include wetting/drying elements). If it appears during the simulation that this criterion has not been correctly set, a warning message will appear in the UNIT 6 and/or UNIT 16 output files. This warning will appear for nodes within the domain for which the elevation-to-depth ratio is less than -0.85.

SLAM0, SFEA0 = Values used only when ICS=1 in conjunction with NCOR=1 and/or NTIP=1 or when ICS=2. SLAM0 and SAFEA0 represent the specified center point of the CPP projection (in degrees longitude and degrees latitude, respectively) used to transform governing equations and/or coordinates. Typically these points should lie at the centroid of the computational domain, although for the case ICS=2, their location will not affect the solution.

FFACTOR = The linear or nonlinear bottom friction coefficient. Whether FFACTOR represents the linear or nonlinear bottom friction coefficient depends on how NOLIBF is specified.

If NOLIBF = 0, τ_* in the bottom friction terms in Equations 2 and 3 is simply set equal to FFACTOR and the bottom friction relationship is effectively linearized. The τ_* value in this case is always used as constant throughout the domain.

If NOLIBF = FFACTOR represents the nonlinear bottom friction coefficient C_f. In this case τ_* is computed as:

$$\tau_* = \frac{C_f\,(U^2 + V^2)^1/2}{h + \xi} \qquad (14)$$

It is noted that FFACTOR is always read in; however, it is not used in the computations when NWP = 1 and NOLIBF = 1. In this case, the C_f values are read in on a nodal basis from UNIT 21 and τ_* is computed using Equation 14 on a nodal basis.

ESL = The spatially homogeneous value for lateral viscosity E_{h2}. This value is always read in; however, it is only used in the computations when NWP=0.

CORI = The spatially homogeneous Coriolis coefficient f. This value is always read in; however, it is only used in the computations when NCOR=0. The value f is computed as $f = 2\Omega sin\phi$ where Ω equals the angular speed of the Earth in radians per second (Ω = 0.00007272205217 rad/sec) and ϕ equals the degrees latitude of the domain in question. If ϕ varies substantially throughout the model domain, the authors recommend setting NCOR=1 and using ADCIRC in spherical form such that ICS=2. Nodal values for f will then be computed within the code based on the specified nodal latitudes in the input coordinates.

NTIF = The number of tidal potential constituents. When tidal potential constituents are forced, ADCIRC should be used in spherical form such that ICS=2.

TIPOTAG(I); I=1, NTIF = An alphanumeric descriptor (i.e., the constituent name) that precedes TPK(I),AMIGT(I),ETRF(I),FFT(I),FACET(I) for each of the NTIF constituents forced in the tidal potential forcing function specified in Equation 4. TIPOTAG(I) is simply specified in order for the user to identify constituents in this input file as well as the UNIT 16 output file. It is read in using an A5 format.

TPK(I),AMIGT(I),ETRF(I),FFT(I),FACET(I); I=1,NTIF = The tidal potential amplitude (in units consistent with the specified value of G, typically meters or feet), frequency (in radians per second), Earth tide potential reduction factor, nodal factor, and equilibrium argument (in degrees) for each of the NTIF constituents. These variables all appear in Equation 4 for the tidal potential forcing function. The tidal potential amplitude TPK(I) or C_{jn} can be obtained from Table 1 in Luettich, Westerink, and Schneffer (1992). The frequency of each constituent included in the tidal potential forcing function, AMIGT(I), is calculated as $2\pi/T_{jn}^{TP}$. In general, it is very important to specify frequencies precisely, at least to eight significant figures. Furthermore, if the same constituents are forced on the open ocean boundaries, the values of the common frequencies should be the same as those specified on the open ocean boundary. The Earth tide potential reduction factor ETRF(I) (designated as α in the governing equations), reduces the tidal potential forcing function η to account for Earth tides. This factor is generally set equal to 0.0690 for all constituents (see Henderschott (1981)) although some evidence exists that α values may vary slightly for

various constituents (Wahr 1981). The nodal factor and equilibrium argument, FFT(I) and FACET(I) ($f_{jn}^{TP}(t_o)$ and ($\psi_{jn}^{TP}(t_o)$, respectively), are computed based on the actual time and date that REFTIM represents (note that REFTIM=t_o). Guidelines as to how to compute f_{jn}^{TP} and ψ_{jn}^{TP} are given by Schureman (1941) and Foreman (1977). If equilibrium tides are directly computed f_{jn}^{TP} and ψ_{jn}^{TP} should be specified as 1.0 and 0.0 for all constituents (although care must be used in the harmonic analysis of the response to ensure that all nodal factors and equilibrium arguments are specified equal to 1.0 and 0.0, respectively). Again, the specification of f_{jn}^{TP} and ψ_{jn}^{TP} should be consistent with values specified for boundary forcing constituents when identical forcing frequencies appear in both the tidal potential and boundary forcing functions. Other components of Equation 4 are obtained from the input coordinates (the λ and ϕ values at the nodes are computed using an inverse CPP projection when ICS=1 and are directly obtained from the input coordinates when ICS=2) or are determined automatically within the code ($L_j(\phi)$ is based on the specified frequency and the value of ϕ).

NBFR = The number of tidal forcing frequencies on open ocean boundaries.

BOUNTAG(I); I=1, NTIF = An alphanumeric descriptor (i.e., the constituent name) that precedes AMIG(I), FF(I), FACE(I) for each of the NBFR constituents forced on the open ocean boundary. BOUNTAG(I) is simply specified in order for the user to identify constituents in this input file as well as the UNIT 16 output file. It is read in using an A10 format.

AMIG(I), FF(I), FACE(I); I=1, NTIF = The boundary forcing frequency, the nodal factor and equilibrium argument (in degrees) for constituents forced on the open ocean boundary. The open ocean boundary forcing function is determined at the boundary forcing nodes as:

$$\zeta(x,y,t) = \sum_{i}^{NTIF} A_i\,(x,y)\, f_i^{BF}\,(t_o) \cos \left[2\pi\,(t - t_0)/T_i^{BF} + V_i^{BF}(t_0) - \Psi_i\,(x,y)\right] \tag{15}$$

The frequency of each constituent included in the open ocean boundary forcing function, AMIG(I), is calculated as $2\pi/T_i^{BF}$ where T_i^{BF} equals the boundary forcing period (in seconds) for the i^{th} constituent. In general, it is very important to specify frequencies precisely, at least to eight significant figures. Furthermore, if the same constituents are forced in the tidal potential forcing function, the values of the common frequencies should be the same as those specified for the tidal potential forcing function. The nodal factor and equilibrium argument, FF(I) and FACE(I) ($f_i^{BF}(t_o)$ respectively), are computed based on the actual time and date that REFTIM represents (note that REFTIM=t_0. Guidelines as

to how to compute f_i^{BF} and v_i^{BF} are given by Schureman (1941) and Foreman (1977). If equilibrium tides are directly computed, f_i^{BF} and v_i^{BF} should be specified as 1.0 and 0.0 for all constituents (although care must be used in the harmonic analysis of the response to ensure that all nodal factors and equilibrium arguments are specified equal to 1.0 and 0.0 respectively). Again, the specification of f_i^{BF} and v_i^{BF} should be consistent with values specified for boundary forcing constituents when identical forcing frequencies appear in both the tidal potential and boundary forcing functions. Other terms in Equation 15 are specified in this input file. REFTIM=t_o has already been specified and the amplitudes of each of the constituents A_i as well as their phases Ψ_i are specified later in this input file for each of the nodes identified as open boundary nodes in the UNIT 14 input file.

ALPHA = An alphanumeric identifier that precedes each of the NBFR sets of amplitudes and phases, EMO(I,J), EFA(I,J); J=1, NETA, at the open boundary nodes for each open boundary forcing frequency. ALPHA is simply specified in order for the user to identify constituents in this input file as well as the UNIT 16 output file. Both BOUNTAG(I) and ALPHA are printed out with the nodal amplitudes and phases in the UNIT 16 output file, enabling the user to ensure that the amplitudes and phases were read in in the correct sequence. ALPHA is read using an A10 format.

EMO(I,J), EFA(I,J); J=1, NETA; I=1, NBFR = The amplitudes A_i and phases (in degrees) Ψ_i of the harmonic forcing function given in Equation 15 at the J=1, NETA open ocean boundary nodes for frequency I. The variable NETA is defined and read in from UNIT 14 input. *These amplitudes and phases represent the equilibrium tidal constituents.* The amplitudes must be read in with units which are consistent with the specified G, i.e., typically meters or feet. Furthermore, the phases must be read in in degrees relative to Greenwich Mean Time if time refers to GMT.

ANGINN = An angle, specified in degrees, that controls which land boundary nodes will have tangential as well as normal velocities zeroed. For land nodes that have an inner angle less than ANGINN, both the normal and tangential velocities will be zeroed. If the inner angle for a land boundary node is greater than ANGINN, only the normal velocity component will be zeroed. Typically ANGINN should be set to about 100 deg such that all land boundary nodes with acute inner angles have zero flow in both directions.

NOUTE, TOUTSE, TOUTFE, NSPOOLE = Output parameters that control the output provided for elevation time histories at selected elevation recording stations. This information will be spooled to UNIT 16 as output. The elevation time history solutions are interpolated to the exact location specified for each elevation recording station.

If NOUTE = 0, no output is provided at the selected elevation recording stations.

If NOUTE = 1, output is provided at the selected elevation recording station in standard ASCII format.

IF NOUTE = 2, output is provided at the selected elevation recording stations in binary format.

TOUTSE = The number of days after which elevation station data is recorded to UNIT 61. TOUTSE is relative to STATIM.

TOUTFE = The number of days after which elevation station data cease to be recorded to UNIT 61. TOUTFE is relative to STATIM.

NSPOOLE = The time-step increment at which elevation time history values at elevation recording stations are spooled to UNIT 61; i.e., the output is spooled to UNIT 61 every NSPOOLE time-steps.

NSTAE = The number of elevation recording stations. This information is always read in regardless of the value of NOUTE.

XEL(I), YEL(I); I=1, NSTAE = The coordinates of the elevation recording station I, for all NSTAE stations. If ICS=1, then these coordinates must be specified in standard Cartesian coordinates in units consistent with the nodal coordinates. If ICS=2, then these coordinates must be specified in spherical coordinates in degrees longitude and latitude. These coordinates should lie within the computational domain and, therefore, within one of the finite elements that make up the domain. If an elevation recording station is input that does not lie within the computational domain, a non-fatal error message will appear. If NFOVER has been set equal to 1, the code will estimate the nearest element and use that as the basis of interpolation. A proximity index is also printed out, which indicates how close or far the station coordinates are from the nearest element. This index may be interpreted as the number of elements that the station lies from the nearest element.

NOUTV, TOUTSV, TOUTFV, NSPOOLV = Output parameters that control the output provided for velocity time histories at selected velocity recording stations. This information will be spooled to UNIT 62 as output. Velocity time history solutions are interpolated to the exact location specified for each velocity recording station.

If NOUTV = 0, no output is provided at the selected velocity recording stations.

If NOUTV = 1, output is provided at the selected velocity recording stations in standard ASCII format.

If NOUTV = 2, output is provided at the selected velocity recording stations in binary format.

TOUTSV = The number of days after which velocity station data are recorded to UNIT 62. TOUTSV is relative to STATIM.

TOUTFV = The number of days after which velocity station data cease to be recorded to UNIT 62. TOUTFV is relative to STATIM.

NSPOOLV = The time-step increment at which velocity time history values at velocity recording stations are spooled to UNIT 62; i.e., the output is spooled to UNIT 62 every NSPOOLV time-steps.

NSTAV = The number of velocity recording stations. This information is always read in regardless of the value of NOUTV.

XEV(I), YEV(I); I=1, NSTAV = The coordinates of the velocity recording station I, for all NSTAV stations. If ICS=1, then these coordinates must be specified in standard Cartesian coordinates in units consistent with the nodal coordinates. If ICS=2, then these coordinates must be specified in spherical coordinates in degrees longitude and latitude. If a velocity recording station is input which does not lie within the computational domain, a non-fatal error message will appear. If NFOVER has been set equal to 1, the code will estimate the nearest element and use that as the basis of interpolation. A proximity index is also printed out, which indicates how close or far the station coordinates are from the nearest element. This index may be interpreted as the number of elements that the station lies from the nearest element.

NOUTGE, TOUTGE, TOUTFGE, NSPOOLGE = Output parameters that control the output provided for global elevation solutions that are written to a UNIT 63 file for all nodes within the domain every NSPOOLGE time-steps.

If NOUTGE = 0, no global elevation output is provided.

If NOUTGE = 1, global elevation output is provided in standard ASCII format.

If NOUTGE = 2, global elevation output is provided in binary format.

TOUTSGE = The number of days after which global elevation solutions are recorded to UNIT 63. TOUTSGE is relative to STATIM.

TOUTFGE = The number of days after which global elevation solutions cease to be recorded to UNIT 63. TOUTFGE is relative to STATIM.

NSPOOLGE = The time-step increment at which global elevation solutions are spooled to UNIT 63; i.e., the output is spooled to UNIT 63 every NSPOOLGE time-steps.

NOUTGV, TOUTGV, TOUTFGV, NSPOOLGV = Output parameters that control the output provided for global velocity solutions that are written to a UNIT 64 file for all nodes within the domain every NSPOOLGV time-steps.

If NOUTGV = 0, no global velocity output is provided.

If NOUTGV = 1, global velocity output is provided in standard ASCII format.

If NOUTGV = 2, global velocity output is provided in binary format.

TOUTSGV = The number of days after which global velocity solutions are recorded to UNIT 64. TOUTSGV is relative to STATIM.

TOUTFGV = The number of days after which global velocity solutions cease to be recorded to UNIT 64. TOUTFGV is relative to STATIM.

NSPOOLGV = The time-step increment at which global velocity solutions are spooled to UNIT 64; i.e., the output is spooled to UNIT 64 every NSPOOLGV time-steps.

NHARFR = The number of frequencies included in the harmonic analysis of the model results. ADCIRC-2DDI has an internal harmonic analysis capability for the time history records of elevation and velocity at the specified recording stations (i.e., those recording stations previously identified in this input file) and of elevation and velocities at global nodes. The harmonic analysis procedure is based on the least squares analysis method (van Ette and Schoemaker 1967, Foreman 1977).

HAFNAML(I) = See description of HAFREQ(I), HAFF(I), HAFACE(I).

HAFREQ(I), HAFF(I), HAFACE(I) I = 1, NHARFR; frequency (rad/sec), nodal factor, equilibrium argument in degrees for inclusion in the harmonic analysis of the model results. These values are preceded by HAFNAM(I), an alphanumeric descriptor (i.e., the constituent name) (no longer than 10 characters). The user must ensure that, at a minimum, all constituents specified in the tidal potential and open ocean boundary forcing functions are included as analysis frequencies. Furthermore, additional constituents generated through nonlinear interactions of the forcing frequencies must be included if they are significant relative to the responses of the frequencies in the forcing functions (see Foreman (1977), Westerink et al. (1989)).

THAS, THAF, NHAINC, FMV = Parameters that control the calculation of harmonic constituents both at stations and globally.

THAS = The number of days after which data start to be harmonically analyzed (THAS is relative to STATIM).

THAF = The number of days after which data cease to be harmonically analyzed (THAF is relative to STATIM).

NHAINC = The time-step increment at which information is harmonically analyzed (information every NHAINC time-steps after THAS is used in the harmonic analysis).

FMW = The fraction of the harmonic analysis period (extending back from the end of the harmonic analysis period) to be used for comparing the water elevation and velocity means and variances from the raw model time series with corresponding means and variances of a time series resynthesized from the harmonic constituents. This comparison is helpful in identifying numerical instabilities and for determining how complete the harmonic analysis was. Example values for FMV are as follows:

FMV = 0.0 - do not compute any means and variances.

FMV = 0.1 - compute means and variances over the final 10 percent of the period used in harmonic analysis.

FMV = 1.0 - compute means and variances over the entire period used in the harmonic analysis.

Notes:

- THAS must be specified sufficiently large that start-up transients (due to the cold starting procedure) have been entirely damped out. This will depend on the basin under study and will typically vary between a few days to several weeks (e.g. see Westerink et al. (1992b)).

- The means and variances of the actual time history of the signal and the resynthesized time history generated from the results of the harmonic analysis are only computed if global harmonic analysis calculations are made (i.e., NHAGE = 1 and/or NHAGV = 1).

- Global results are written out to UNIT 55.

- A summary of the poorest comparisons throughout the domain and the node numbers where these occurred is given at the end of the UNIT 16 output file.

- The time series resynthesis from the harmonic constituents can use up a lot of CPU time, since this is done for every NHAINC time-step during the specified part of the harmonic analysis period. If the harmonic analysis period extends for only a few days, it is practical to set FMV = 1. Otherwise, it becomes extremely time consuming to compute means and variances for more than 10-20 days. Note, however, that the practical limit to these calculations will depend on the number of nodes, the number of constituents in the harmonic analysis, and the size of the time-step (number of time-steps per day).

NHASE, NHASV, NHAGE, NHAGV = Parameters which control spatial locations where the harmonic analysis is performed.

NHASE = 0, no harmonic analysis is performed at the selected elevation recording stations.

NHASE = 1, a harmonic analysis is performed at the selected elevation recording stations (output to UNIT 51). Note that the stations are as specified in the section on time series station elevation output.

NHASV = 0, no harmonic analysis is performed at the selected velocity recording stations.

NHASV = 1, a harmonic analysis is performed at the selected velocity recording stations (output to UNIT 52). Note that the stations are as specified in the section on time series station velocity output.

NHAGE = 0, no harmonic analysis is performed for global elevations.

NHAGE = 1, harmonic analysis is performed for global elevations (output to UNIT 53).

NHAGV = 0, no harmonic analysis is performed for global velocities.

NHAGV = 1, harmonic analysis is performed for global velocities (output to UNIT 54).

NHSTAR, NHSINC = Parameters which control the generation of hot-start output files.

NHSTAR = 0, no hot-start output files are generated.

NHSTAR = 1, hot-start output files are generated.

NHSINC = The number of time-steps at which a hot-start output file is generated (a hot-start file is generated every NHSINC time-steps). How often hot-start files are generated depends on the stability, performance, and load of the computer on which ADCIRC is

being run. As a norm, it is suggested that a hot-start file be generated at least every 12 hr of CPU time.

ITITER, ISLDIA, CONVCR, ITMAX = Parameters that provide information about the simultaneous linear algebraic equation solver that will be used. Note that all of the parameters must be input regardless of whether a direct or iterative solver is selected. However, ISLDIA, CONVCR, and ITMAX are only used with the interactive solvers.

ITITER = a parameter that specifies the solver to be used in ADCIRC.

ITITER = 0, use a direct banded solver from the LINPACK library (Dongarra et al. 1979).

ITITER = 1, use the interactive JCG solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 2, use the interactive JSI solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 3, use the interactive SOR solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 4, use the interactive SSORCG solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 5, use the interactive SSORSI solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 6, use the interactive RSGC solver from the ITPACK 2D library (Kincaid et al. 1989).

ITITER = 7, use the interactive RSSI solver from the ITPACKV 2D library (Kincaid et al. 1989).

ISLDIA is used to control the level of diagnostic output from the ITPACKV 2D solver. Each higher value provides additional information.

ISLDIA = 0, fatal error messages from ITPACKV 2D are output to UNIT 33.

ISLDIA = 1. in addition to the above, warning messages from ITPACKV 2D are output to UNIT 33.

ISLDIA = 2, in addition to the above, a reasonable summary of algorithm progress from ITPACKV 2D is output to UNIT 33.

ISLDIA = 3, in addition to the above, parameter values and informative comments from ITPACKV 2D are output to UNIT 33.

ISLDIA = 4, in addition to the above, approximate solutions after each iteration from ITPAKCV 2D are output to UNIT 33.

ISLDIA = 5, in addition to the above, the original system from ITPACKV 2D is output to UNIT 33.

CONVCR = An absolute convergence criteria, which should be no smaller than 500 times the machine precision.

ITMAX = The maximum number of iterations for each time-step.

The authors have had the best success using the JCG solver, although the JSI also works well. The other iterative solvers either blow up rapidly or do not work because the grid can not be red/black ordered. The authors typically use CONVCR=1E-6 on the CRAY and CONVCR=2.98E-5 on a 32-bit machine. After the first few time-steps, the solutions usually converge within 5 to 10 iterations.

Description of the Input Variables Read in from UNIT 21

The UNIT 21 (defined as "fort.21" by ADCIRC) input file is only necessary when NWP in UNIT 15 has been specified equal to 1. This corresponds to cases for which the nonlinear bottom friction coefficient and/or lateral viscosity coefficient vary in space. Both the bottom friction coefficient C_f, and the lateral viscosity coefficient E_{h2} vary linearly over the element. The format for all lines is free format unless otherwise noted.

AFRIC = An Alphanumeric file identification for the friction/lateral viscosity file. AFRIC is read in using an A24 format.

JKI, FRIC(JKI), EVC(JKI); JKI=1,NP = The node number, the nodal value for the nonlinear bottom friction coefficient C_f, and the nodal value for the lateral viscosity coefficient E_{h2}. Lines for each node must be read in sequential order.

Description of the Input Variables Read in from UNIT 22

The UNIT 22 input file (defined as "fort.22" by ADCIRC) is only necessary when NWS in UNIT 15 has been specified equal to 1. This corresponds

to cases where a non-zero free surface shear stress or atmospheric pressure is applied. The format for all lines is free format.

NHG, WSX2(NHG), WSY2(NHG), PRS2(NHG); NHG=1,NP = The node number, applied horizontal free surface stress in the x-direction divided by the reference density of water at the node, applied horizontal free surface stress in the y-direction divided by the reference density of water at the node, applied atmospheric pressure at the surface divided by the reference density of water at the node and gravity. Therefore these variables are defined as:

$$WSX2 = \frac{\tau_{sx}}{\rho_0} \tag{16}$$

$$WSY2 = \frac{\tau_{sy}}{\rho_0} \tag{17}$$

$$PRS2 = \frac{p_s}{\rho_0 g} \tag{18}$$

The first data set must be provided at TIME=STATIM+DT and subsequent data sets must be provided at every time-step.

Description of the Input/Output Files UNITS 67 and 68

The UNIT 67 and 68 files (defined as "fort.67" and "fort.68" by ADCIRC) are hot-start files actually generated by ADCIRC itself. Their generation as output is activated by UNIT 15 parameters NHSTAR and NHSINC and their use as input files is activated by the UNIT 15 parameter IHOT. When NHSTAR is specified equal to 1 in the UNIT 15 input file, these files are alternatively generated every NHSINC time-steps; i.e., NHSINC steps after the start of time stepping, hot-start information is written to UNIT 67; 2*NHSINC time-steps after the start of time stepping, hot-start information is written to UNIT 68; 3*NHSINC time-steps after the start of time stepping, hot-start information is written to UNIT 67; the pattern keeps repeating itself. The reason for alternating between two hot-start files is that there will always be at least one completed hot-start file in case the computer goes down during the time information is being written to either UNIT 67 or UNIT 68.

If an ADCIRC run is interrupted by computer failure, it can be restarted simply by determining the most recent completed hot-start file and specifying IHOT in the UNIT 15 input file equal to either 67 or 68 (depending on whether UNIT 67 or 68 is the most completed hot-start file). The ADCIRC

run will then continue time marching automatically from the time the hot-start file was written. Hot-start files are always written in binary format.

5 Output File Description

There are one standard and thirteen supplemental output files. The standard output file consists of UNIT 16 (defined as "fort.16" by ADCIRC). UNIT 16 is the output file that echo prints all input variables, including grid information (from UNIT 14 input), variable and forcing information (from UNIT 15), and information from the optional input files. UNIT 16 output also provides processed information and prints error messages regarding program use.

The supplement output files are UNITS 6, 33, 51, 52, 53, 54, 55, 61, 62, 63, 64, 67, and 68. These files are activated by input parameters specified in UNIT 15. UNIT 6 and 33 output files include mainly diagnostic information. UNIT 6 (defined as the screen or "fort.6" by ADCIRC) output corresponds to a screen output that provides limited run time information as well as warnings. In addition UNIT 6 scrolls the maximum elevation and velocity values within the domain and the nodes at which they occur. This allows the user to monitor the solution. UNIT 6 output is activated or suppressed by the UNIT 15 input parameter NSCREEN. UNIT 33 (defined as "fort.33" by ADCIRC) outputs diagnostic information from the ITPACKV 2D solver if this package is selected as the simultaneous linear algebraic solver in the UNIT 15 input file. The level of diagnostic detail output to UNIT 33 depends on the value of the UNIT 15 input parameter ISLDIA.

UNITS 51, 52, 53, and 54 (defined as "fort.51", "fort.52", "fort.53", and "fort.54" by ADCIRC) contain harmonic constituent information for elevation at the defined elevation recording stations, velocities at the defined velocity recording stations, elevation at global nodes, and velocities at global nodes, respectively. These output files are controlled by UNIT 15 input parameters NHASE, NHASV, NHAGE, and NHAGV as well as NHARFR, HAFNAM(I), HAFREQ(I), HAFF(I), HAFACE(I), I=1, NHAFRF, THAS, THAF, and NHAINC. These files are always printed out as ASCII files. UNIT 55 (defined as "fort.55" by ADCIRC) contains a comparison between the mean and the variance of the time series generated by ADCIRC and the mean and variance of the time series internally resynthesized by ADCIRC from the computed harmonic constituents. This gives an indication of how complete the harmonic analysis constituents specified in UNIT 15 were in adequately analyzing the actual time history signals for elevation and velocities at both specified stations and global nodes. UNIT 55 output is controlled by the same

UNIT 15 parameters that control UNIT 51, 52, 53, and 54 output in addition to the UNIT 15 parameter FMV.

UNIT 61 (defined as "fort.61" by ADCIRC) consists of elevation values at specified elevation recording stations spooled every NSPOOLE time-steps. UNIT 62 (defined as "fort.62" by ADCIRC) consists of velocity values at specified velocity recording stations spooled every NSPOOLV time-steps. UNIT 63 (defined as "fort.63" by ADCIRC) consists of elevations at all nodes spooled every NSPOOLGE time-steps. Finally, UNIT 64 (defined as "fort.64" by ADCIRC) consists of velocities at all nodes spooled every NSPOOLGV time-steps. All files can be not written, written in ASCII, or written in binary form (depending on the specified values of UNIT 15 input parameters NOUTE, NOUTV, NOUTGE, and NOUTGV). The starting reference time for the computations is TIME=STATIM. Output data sets spooled to these files are tagged with the variables TIME=STATIM+IT*DT (where IT=time-step) as well as with IT.

Finally, the hot-start files UNITS 67 and 68 are fully described in the section of Chapter 4 entitled "Description of the Input/Output Files UNITS 67 and 68."

Description of Output Variables Written to UNIT 51

NHARFR = Number of frequencies used in the harmonic analysis.

AMIGT(I), FFT(I), FACET(I), TPK(I) = Constituent frequencies, nodal factors, equilibrium arguments, constituent names.

NSTAE = Number of elevation stations included in the harmonic analysis.

(J, (AMP(I,J), PHASE(I,J) I=1,NHARFR) J=1,NSTAE = Station number, elevation amplitudes, and phases for each of the NHARFR analyzed constituents at each station.

Description of Output Variables Written to UNIT 52

NHARFR = Number of frequencies used in the harmonic analysis.

AMIGT(I), FFT(I), FACET(I), TPK(I) = Constituent frequencies, nodal factors, equilibrium arguments, constituent names.

NSTAV = Number of velocity stations included in the analysis.

(J,(UAMP(I,J), UPHASE(I,J), VAMP(I,J), VPHASE(I,J) I=1,NHARFR) J=1,NSTAV) = Station number, amplitudes, and phases for the x or y (or λ and ϕ) components of velocity for each of the NHARFR analyzed constituents at each station.

Description of Output Variables Written to UNIT 53

NHARFR = Number of frequencies used in the harmonic analysis.

AMIGT(I), FFT(I), FACET(I), TPK(I) = Constituent frequencies, nodal factors, equilibrium arguments, constituent names.

NP = Number of nodes in the grid.

(J,(AMP(I,J), PHASE(I,J)I=1,NHARFR) J=1,NP) = Node number, elevation amplitudes, and phases for each of the NHARFR analyzed constituents at each node.

Description of Output Variables Written to UNIT 54

NHARFR = Number of frequencies used in the harmonic analysis.

AMIGT(I), FFT(I), FACET(I), TPK(I) = Constituent frequencies, nodal factors, equilibrium arguments, constituent names.

NP = Number of nodes in grid.

(J,(UAMP(I,J), UPHASE(I,J), VAMP(I,J), VPHASE(I,J) I=1,NHARFR) J=1,NP) = Node number, amplitudes, and phases for the x and y (or λ and ϕ) components of velocity for each of the NHARFR analyzed constituents at each node.

Description of Output Variables Written to UNIT 55

NP = Number of nodes in grid.

J = Node number

TSEA(J), HAEA(J), HAEA(J)/TSEA(J), TSEV(J), HAEV(J), HAEV(J)/TSEV(J) TSUA(J), HAUA(J), HAUA(J)/TSUA(J), TSUV(J), HAUV(J), HAUV(J)/TSUV(J) TSVA(J), HAVA(J), HAVA(J)/TSVA(J), TSVV(J), HAVV(J), HAVV(J)/TSVV(J) J=1,NP)

TSEA = Mean elevation in the raw model time series.

HAEA = Mean elevation in the resynthesized time series.

TSEV = Elevation variance in the raw model time series.

HAEV = Elevation variance in the resynthesized time series.

TSUA = Mean *x*-velocity in the raw model time series.

HAUA = Mean *x*-velocity in the resynthesized time series.

TSUV = *x*-velocity variance in the raw model time series.

HAUV = *x*-velocity variance in the resynthesized time series.

TSVA = Mean *y*-velocity in the raw model time series.

HAVA = Mean *y*-velocity in the resynthesized time series.

TSVV = *y*-velocity variance in the raw model time series.

HAVV = *y*-velocity variance in the resynthesized time series.

Description of Output Variables Written to UNIT 61

RUNDES, RUNID, AGRID = Alphanumeric descriptors that are discussed in the UNIT 14 and 15 input descriptions.

NTRSPE, NSTAE, DT*NSPOOLE, NSPOOLE, IRTYPE = Output parameters that describe the data spooled to UNIT 61.

NTRSPE = Number of data sets to be written to UNIT 61.

NSTAE = Number of stations within each data set.

DT*NSPOOLE = Time increment (in seconds) between consecutive data sets.

NSPOOLE = Time-step increment between consecutive data sets.

IRTYPE = Record type, which equals 1 for elevation files.

TIME, IT, (ET00(I); I=1,NSTAE) = Time (in seconds), time-step, and surface elevation values at NSTAE elevation recording stations.

Description of Output Variables Written to UNIT 62

RUNDES, RUNID, AGRID = Alphanumeric descriptors that are discussed in the UNIT 14 and 15 input descriptions.

NTRSPV, NSTAV, DT*NSPOOLV, NSPOOLV, IRTYPE = Output parameters that describe the data spooled to UNIT 62.

NTRSPV = Number of data sets to be written to UNIT 62.

NSTAV = Number of stations within each data set.

DT*NSPOOLV = Time increment (in seconds) between consecutive data sets.

NSPOOLV = Time-step increment between consecutive data sets.

IRTYPE = Record type, which equals 2 for velocity files.

TIME, IT, (UU00(I), VV00(I); I=1,NSTAV) = Time (in seconds), time-step, and the x and y direction velocities, respectively, at NSTAV velocity recording stations.

Description of Output Variables Written to UNIT 63

RUNDES, RUNID, AGRID = Alphanumeric descriptors that are discussed in the UNIT 14 and 15 input descriptions.

NDSETSE, NP, DT*NSPOOLGE, NSPOOLGE, IRTYPE = Output parameters that describe the data spooled to UNIT 63.

NDSETSE = The number of data sets to be spooled to UNIT 63.

NP = The number of node points within each data set.

DT*NSPOOLGE = The time increment (in seconds) between consecutive data sets.

NSPOOLGE = The time-step increment between consecutive data sets.

IRTYPE = The record type, which equals 1 for elevation files.

TIME, IT = Time (in seconds) and time-step at which results at all nodes are provided.

I, ETA2(I); I=1,NP = The node number and surfaced elevation for all nodes at TIME. For the binary output option, the code does not print out the node numbers.

Description of Output Variables Written to UNIT 64

RUNDES, RUNID, AGRID = Alphanumeric descriptors that are discussed in the UNIT 14 and 15 input descriptions.

NDSETS, NP, DT*NSPOOLGV, NSPOOLGV, IRTYPE = Output parameters that describe the data spooled to UNIT 64.

NDSETSV = Number of data sets to be spooled to UNIT 64.

NP = Number of node points within each data set.

DT*NSPOOLGV = Time increments (in seconds) between consecutive data sets.

NSPOOLGV = Time-step increment between consecutive data sets.

IRTYPE = Record type, which equals 2 for velocity files.

TIME, IT = Time (in seconds) and time-step at which results at all nodes are provided.

I, UU2(I), VV2(I); I=1,NP = Node number, *x*-direction velocity, and *y*-direction velocity for all nodes at TIME. For the binary output option, the code does not print out the node numbers.

6 Example 1; The Quarter Annular Test Case

The first example presented is the quarter annular test problem developed by Lynch and Gray (1978). This problem is very popular and is used to assess the performance of numerical schemes in solving the shallow-water equations for complex geometries and bathymetries. The problem as presented is run to solve the fully linearized form of the shallow-water equations.

The details of the problem run are described first. Some of the results for this run are then presented in graphical form and briefly discussed. Sample input files for UNITS 14 and 15, in addition to the corresponding output files for UNITS 6, 16, 51, 52, 53, 54, 55, 61, 62, 63, and 64, are provided in Appendix A. The italicized text in the input and output files corresponds to the description of the input variables or modifications to the output files.

Description of the Problem

The quarter annular test problem gives considerable insight into the ability of a numerical scheme to propagate both high and low wave number energy. Poor numerical schemes will show spurious modes and/or excessive numerical dissipation for this problem. The geometry for the quarter annular test problem is presented in Figure 1. The domain consists of a quarter of an annulus enclosed with land boundaries on three sides and an open ocean boundary on the outer edge. Bathymetry is constant throughout the domain at 30 ft. The dimensions used for this problem are an inner radius of $r_1 = 2 \times 10^6\ ft$ and an outer radius of $r_a = 5 \times 10^6\ ft$.

The standard finite element discretization for this problem is shown in Figure 2. Both node and element numbers are indicated in this figure. The grid is discretized in a radial manner using $\Delta r = 5 \times 10^4 ft$ and $\Delta\theta = \pi/16$.

All nonlinearities are turned off and linear bottom friction is specified such that $\tau_* = 0.0001 sec^{-1}$. The Coriolis factor f is set to zero. No tidal potential forcing function is specified. The open ocean boundary nodes are forced with

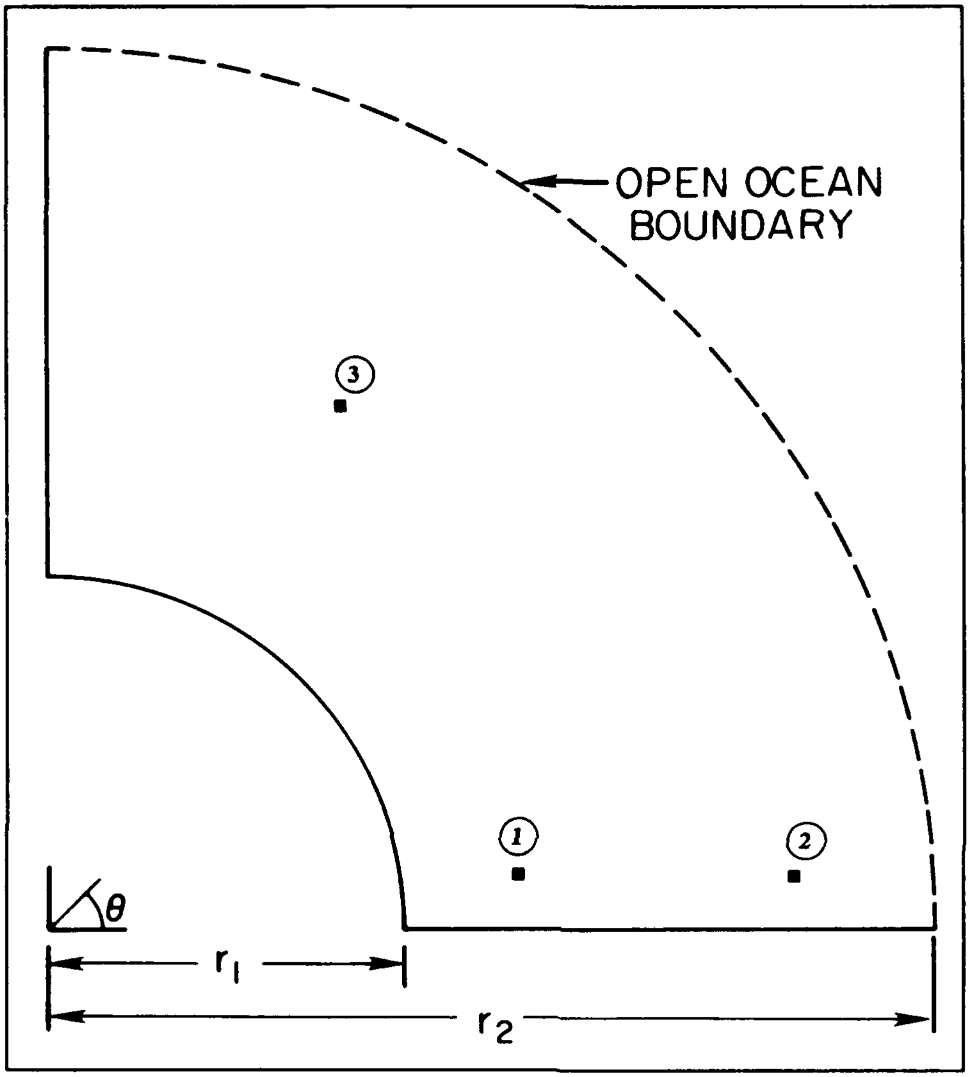


Figure 1. Geometry of the quarter annular test problem showing the location of the elevation and velocity stations (stations 1, 2, and 3)

a sinusoidal forcing function, $\zeta(t) = 1.00\sin(\omega_1 t)$ where $\omega_1 = 2\pi/T_1$ and T_1 corresponds to a 12.4-hr semidiurnal period. Finally, land boundaries have zero normal velocity boundary conditions applied. In addition, any inner angle on the boundary that is less than 110 deg has both normal and tangential velocity specified equal to zero.

Results are recorded at the three stations indicated in Figure 1. For this particular case, these locations will serve as both elevation recording stations and velocity recording stations. In addition, global elevation and velocity results are recorded. Furthermore, time histories are harmonically analyzed at both elevations and velocity recording stations as well as for elevations and velocities at global nodes. The harmonic analysis is performed using only the

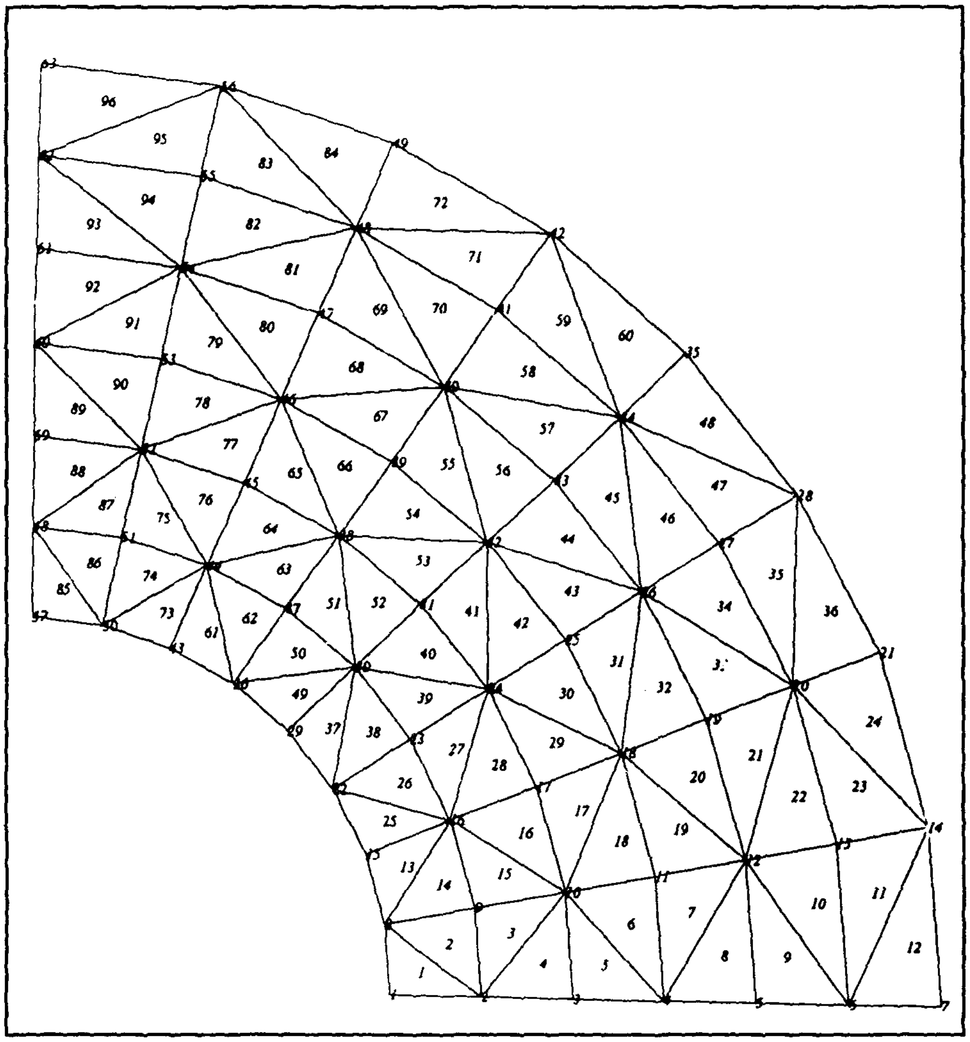


Figure 2. Finite element discretization of the quarter annular test problem showing node and element numbers

M_2 constituent (since this is a linear run and there is only one forcing and response frequency) and time history records between 5 and 8 days. Finally, the simultaneous linear algebraic equations are solved using a banded solver from the LINPACK library.

Results for the Quarter Annular Test Problem

Figure 3 presents the time history plots of surface elevation interpolated to the three elevation recording stations. These figures are obtained by plotting the information in the UNIT 61 output file. The effect of the start-up ramp on the signal, which reaches a dynamic steady state in about 4 to 5 days, can be noted. The model does not produce any spurious oscillations. Figures 4 and 5

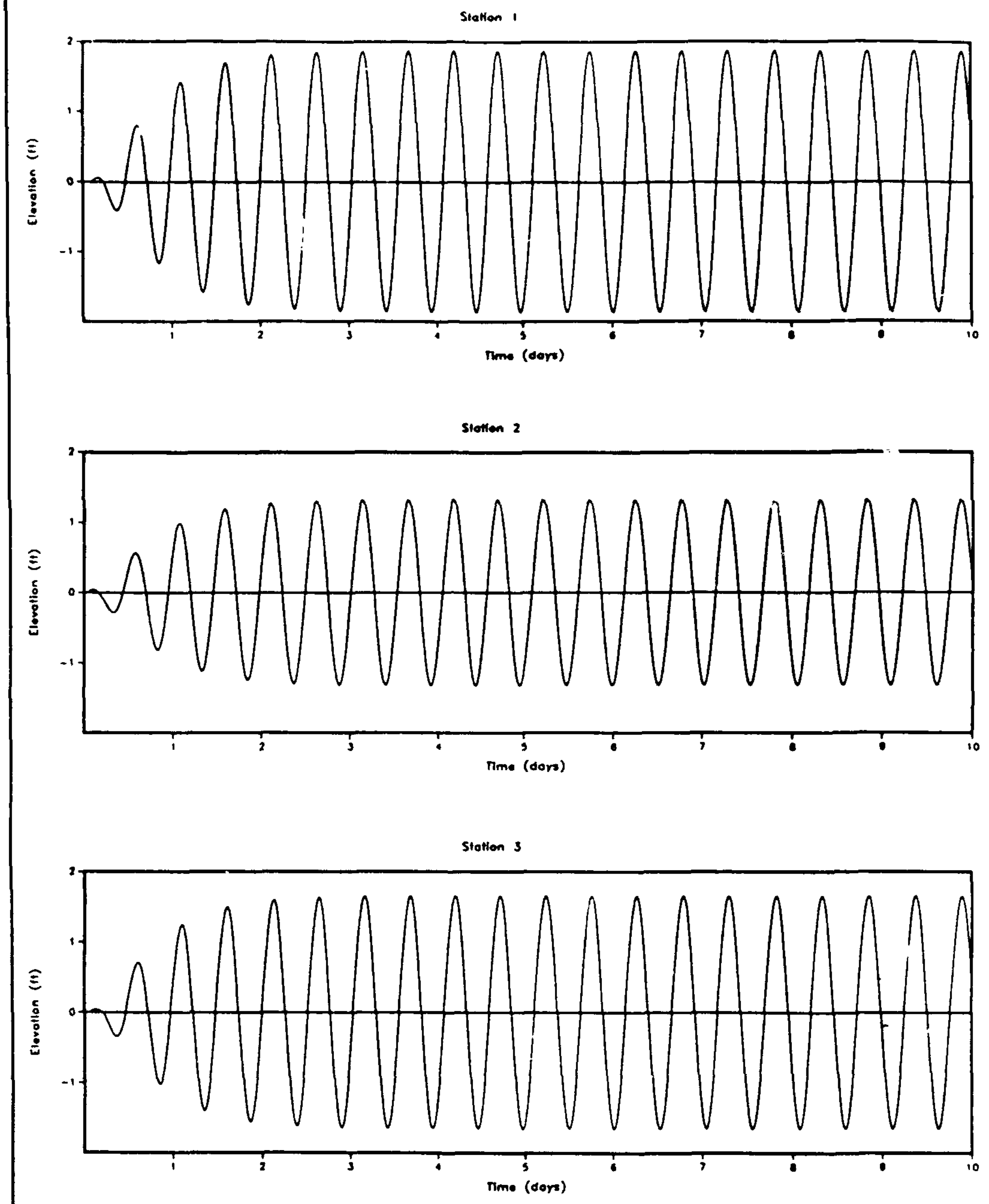


Figure 3. Time histories of the computed elevations at the three elevation recording stations

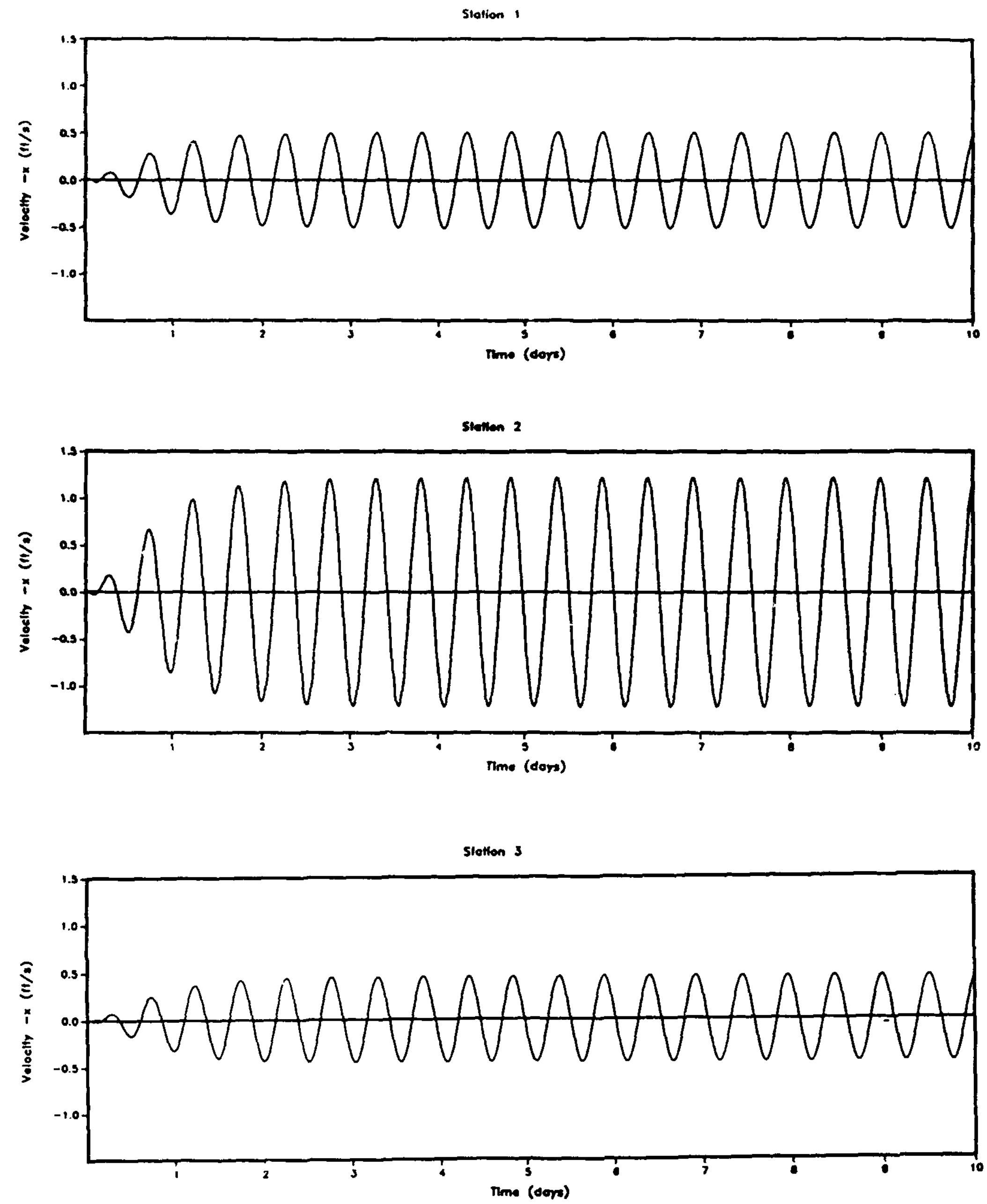


Figure 4. Time histories of the computed *x* component velocities at the three velocity recording stations

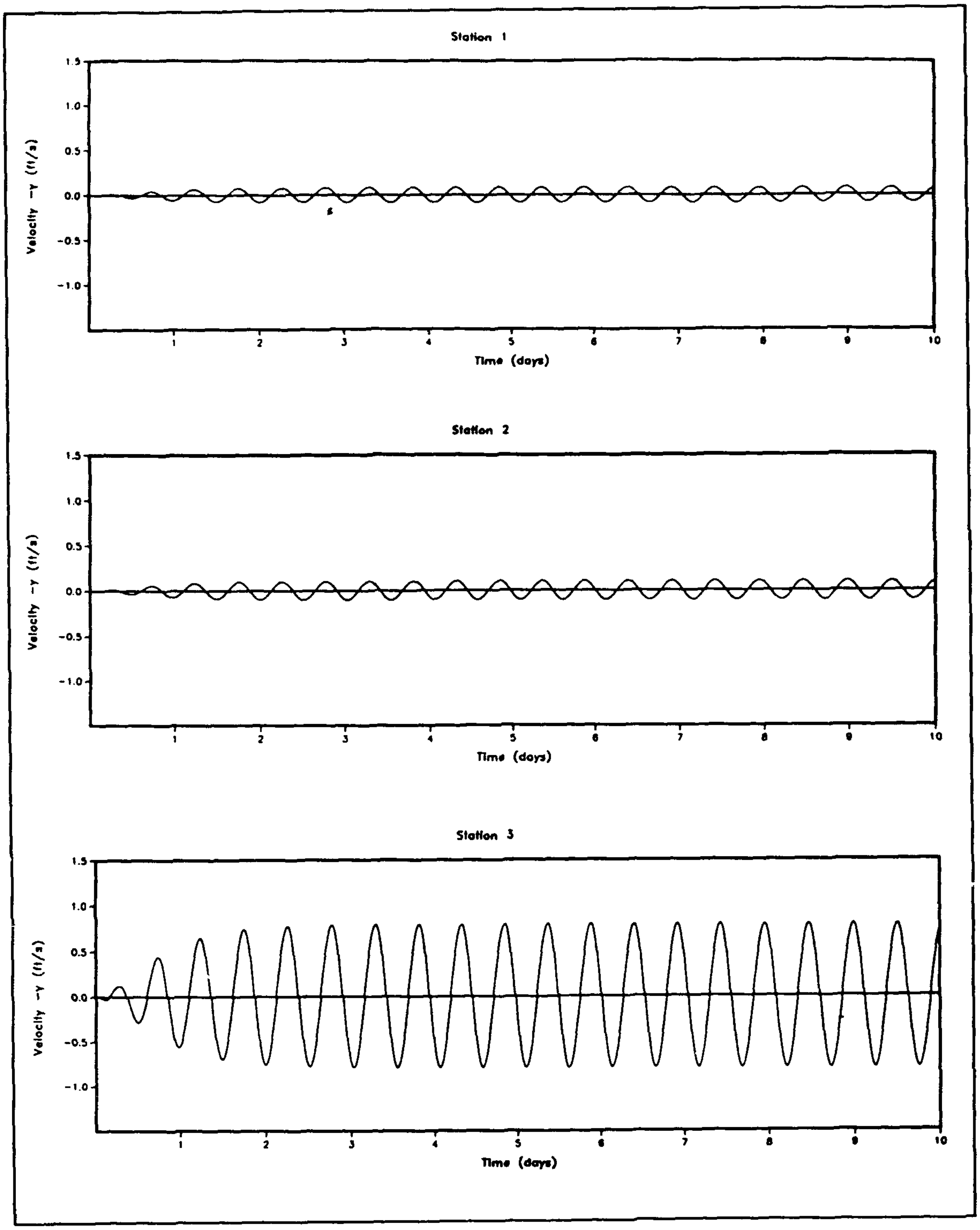


Figure 5. Time histories of the computed *y* component velocities at the three velocity recording stations

show the time history plots of the x and y componenets of velocity at the three velocity stations (which, in this particular example, coincide with the elevation stations). These figures are obtained by plotting the information in the UNIT 62 output file. Figure 6 plots the surface elevation contours at TIME = 213,255 sec (or 1,221 time-steps into the simulation) using the UNIT 63 output file in conjunction with the graphics code XMVIS (Baptista and Turner 1992). Finally, Figure 7 depicts the velocity vectors (at the nodes) at TIME = 213,255 sec (or 1,221 time-steps into the simulation) using the UNIT 64 output file in conjunction with the graphics code XMVIS.

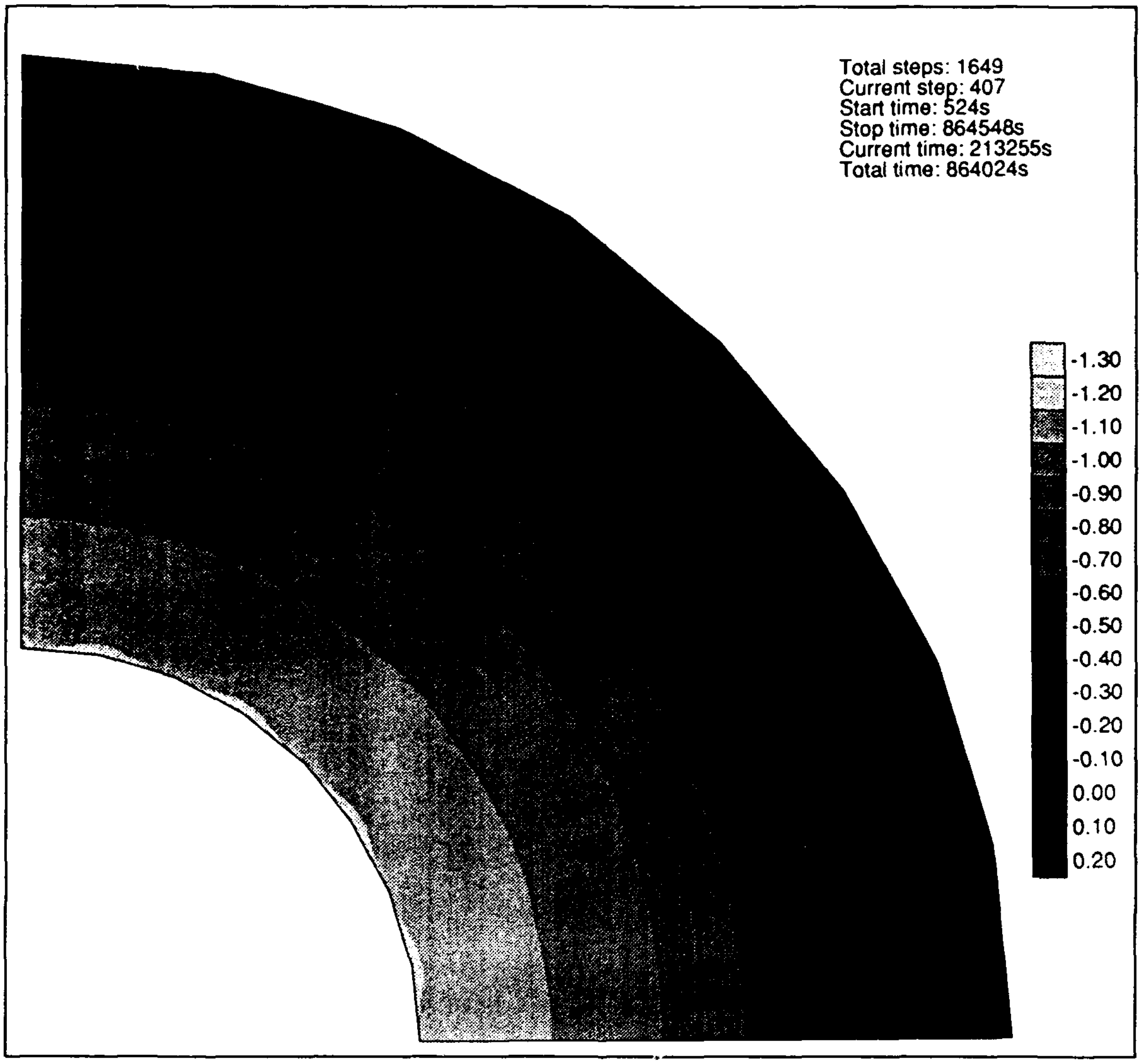


Figure 6. Surface elevation contours for the quarter annular case shown using XMVIS

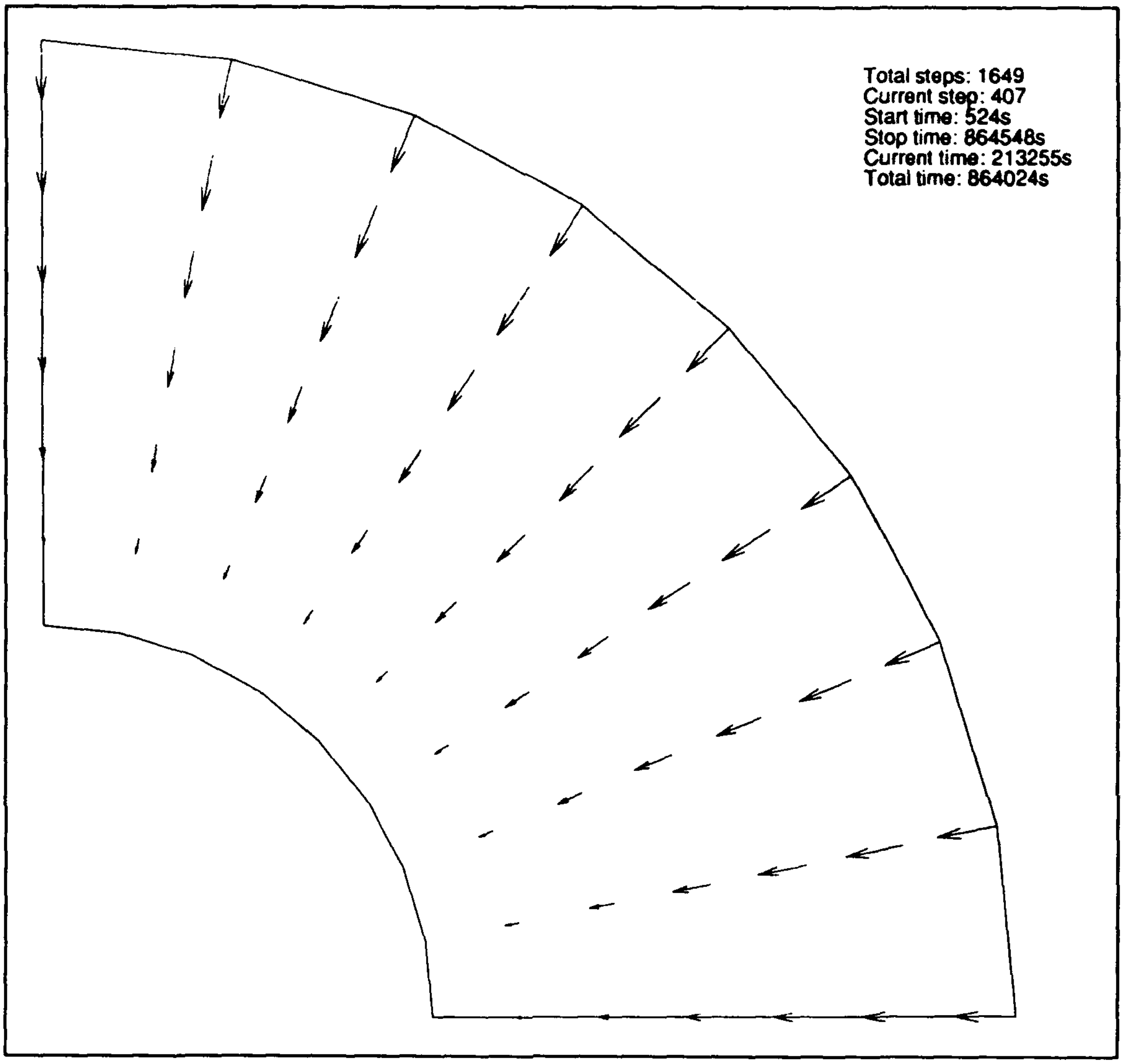


Figure 7. Velocity vector field for the quarter annular case shown using XMVIS

7 Example 2; An Application to the Gulf of Mexico

The second example presented is the application of ADCIRC-2DDI to the Gulf of Mexico in order to compute tides and tidal currents. This problem is described in detail by Westerink et al. (1992a). The problem as presented is run to solve the fully nonlinear form of the shallow-water equations. It is run using the spherical form of the governing equations. The problem also includes tidal potential forcing and a spatially nonhomogeneous Coriolis coefficient. Details of the modeling strategy and the development of the computational domain are first described. Details of the application for computing tidal elevations within the entire Gulf, as well as computing tidal currents within the Mississippi Sound, are then described. Finally, the results of this application are discussed. Sample input files for UNITS 14 and 15 and the corresponding output files for UNITS 6, 16, 51, 52, 53, 54, 55, 61, 62, 63, and 64 are presented in Appendix B.

Modeling Strategy and Computational Domain

The region of general interest within the Gulf of Mexico for this application consists of the coast between the Mississippi Sound off of Mississippi and St. Marks, Florida, as shown in Figure 8. Due to the complex nature of tides and hurricanes in the Gulf of Mexico, it is very difficult to define surface elevations and/or currents to drive the boundaries of a regional model that encompasses only the immediate area of interest. Flow features such as resonant shelf edge waves, hurricane forerunner, and/or the complex wind patterns associated with a hurricane driving the flow onto the shelf, make it desirable to define larger computational domains, including regions well beyond the continental shelf adjacent to the area of interest. The modeling strategy has been to define the entire Gulf of Mexico as the computational domain and to refine the region of interest using the significant grid flexibility offered by the finite element method and the ADCIRC codes. Using the entire Gulf as the pertinent domain is quite convenient from a variety of perspectives. Most importantly, two well-defined open ocean boundaries of limited extent can be used to specify the boundary forcing functions that define the interaction between the Atlantic Ocean and Caribbean Sea with the Gulf. The open boundary

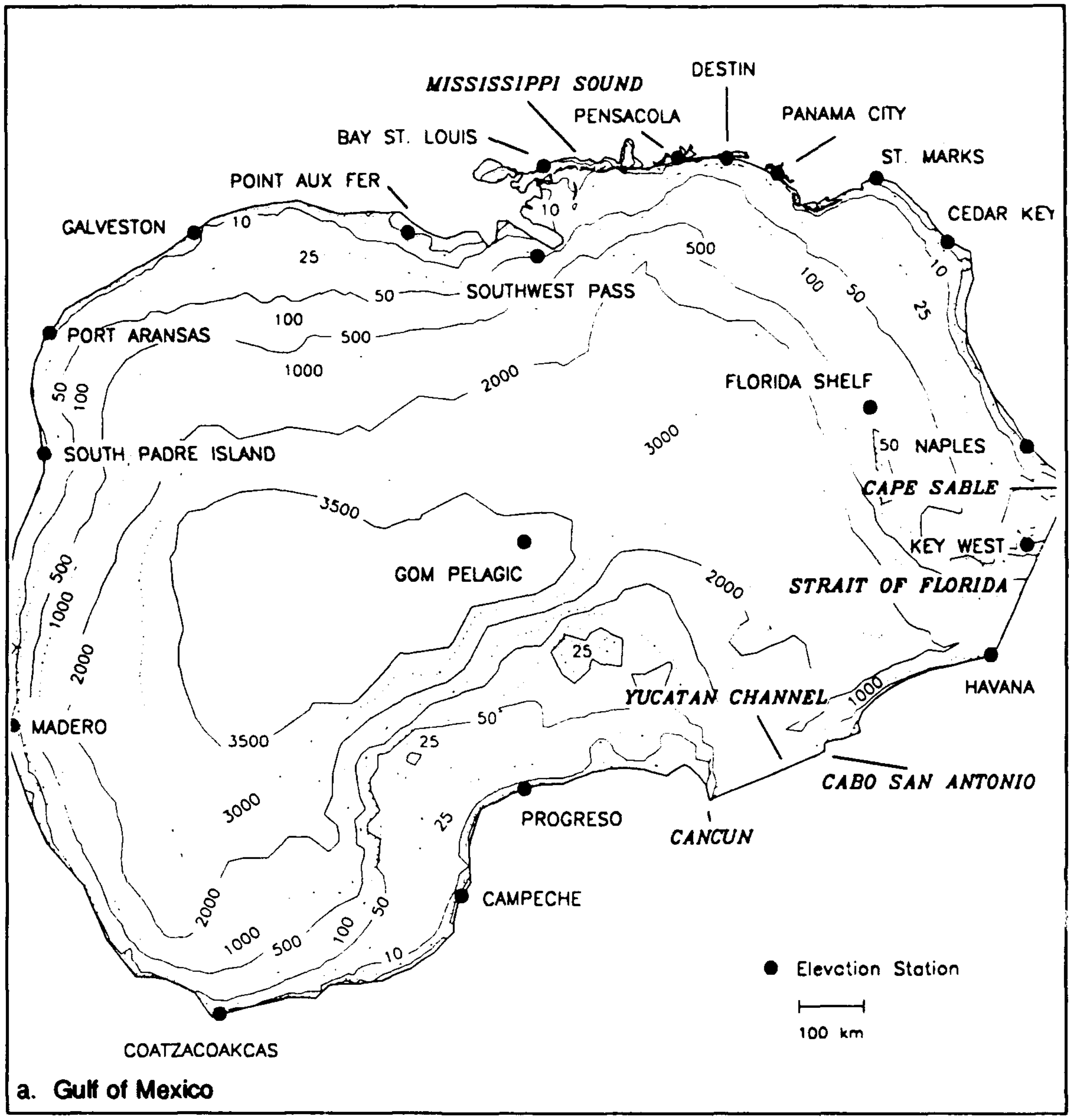
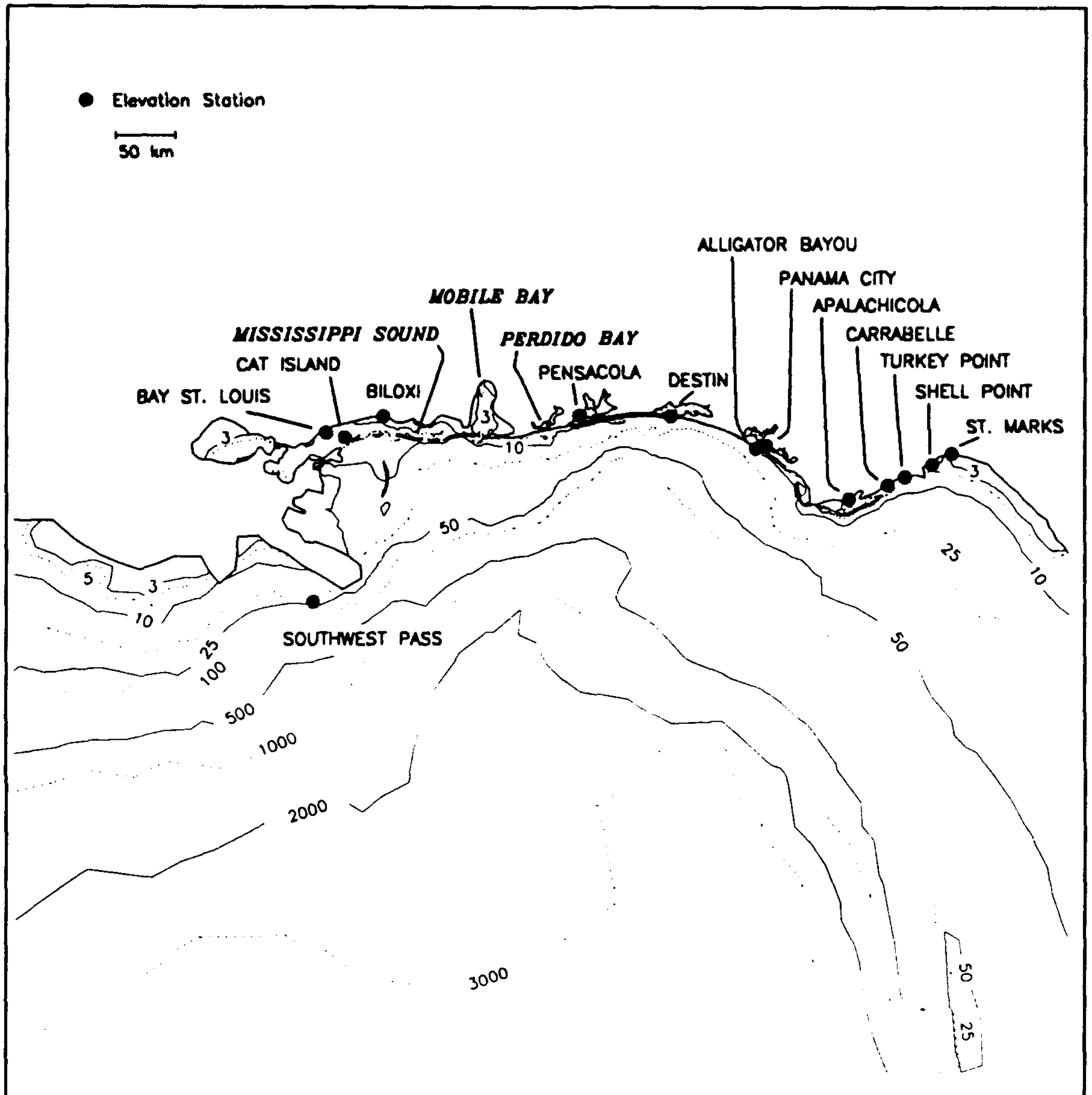


Figure 8. Maps of pertinent regions within the Gulf of Mexico including tidal elevation data recording stations (in bold letters), velocity recording stations (in bold letters), geographic locations of interest (in italics), and bathymetry (in meters) (Sheet 1 of 3)

across the Strait of Florida was selected to run from Cape Sable in Florida to Havana, Cuba, and is in the vicinity of two long-term tidal stations (Key West, Florida and Havana, Cuba). Sea surface elevation boundary conditions were established across this boundary by interpolating linearly between Havana and the boundary node nearest Key West and maintaining a constant value between the node nearest Key West and Cape Sable. The second open boundary stretches across the Yucatan Channel from the vicinity of Cancun, Mexico to Cabo San Antonio, Cuba. Although no reliable tidal data are available near



b. Detail of the coastline between the Mississippi Sound and St. Marks, Florida

Figure 8. (Sheet 2 of 3)

this boundary, a detailed study by Reid and Whitaker (1981) has established sea surface conditions near this boundary. For the purpose of this study, it was assumed that sea elevation was constant across this boundary for each included tidal constituent.

The bathymetry in the Gulf of Mexico varies dramatically, as is illustrated in Figure 8. Bathymetric data in most of the Gulf were obtained from the ETOPO5 database from the National Center for Atmospheric Research and were supplemented by the National Oceanic and Atmospheric Administration (NOAA) Digital U.S. Coastal Hydrography sounding database (distributed by

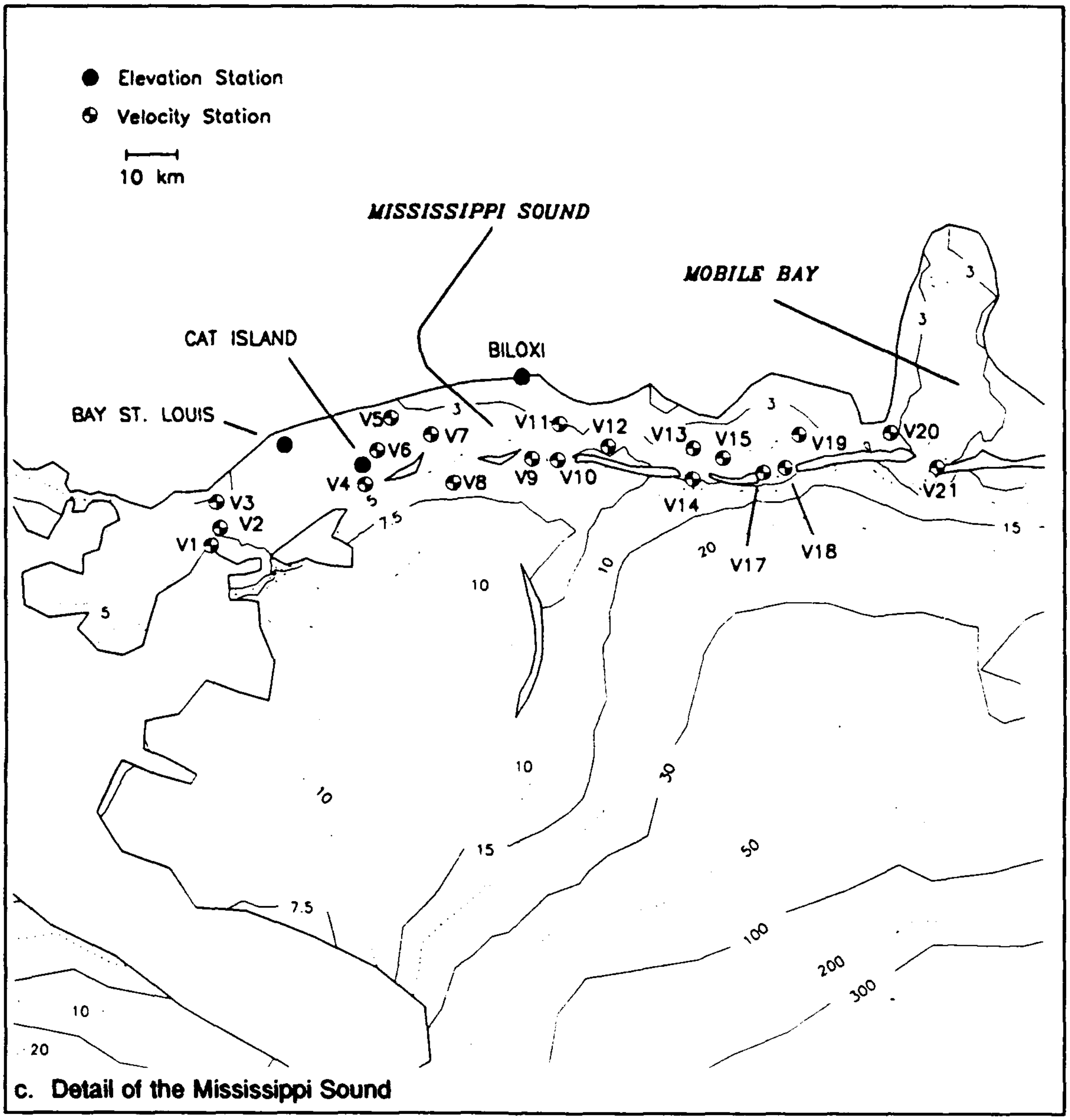


Figure 8. (Sheet 3 of 3)

NOAA National Geophysical and Solar-Terrestrial Data Center in Boulder, CO) from the Mississippi Sound to St. Marks. For actual simulations a minimum bathymetry of 3 m was specified.

The final FE grid used is shown in Figure 9. This grid was generated with program XMGREDIT, a flexible interactive grid generation facility developed by Turner and Baptista (1992). The grid shown in Figure 9 has been iteratively refined and is based on evaluations of the performance of the hydrodynamic code as well as assessments of convergence between successive levels of grid refinement. In general, the continental shelf regions are discretized

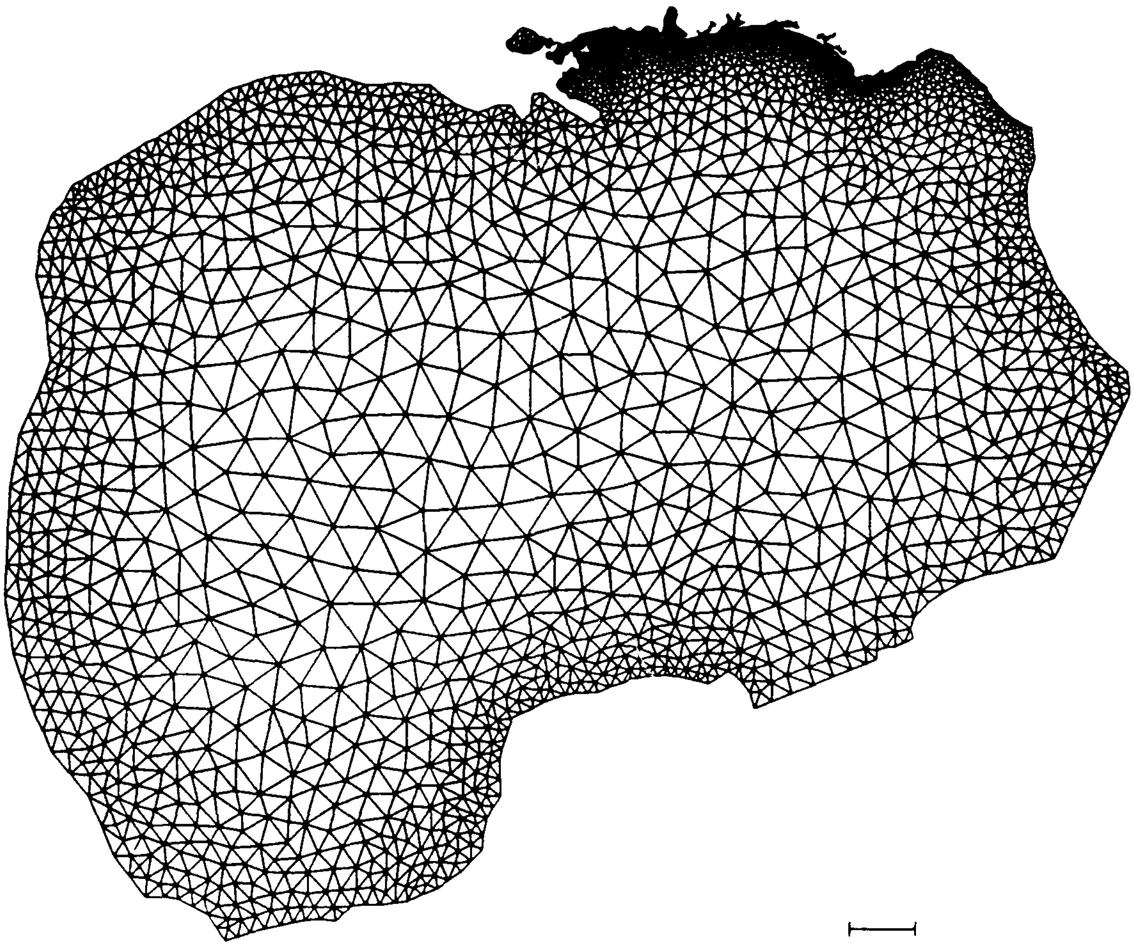
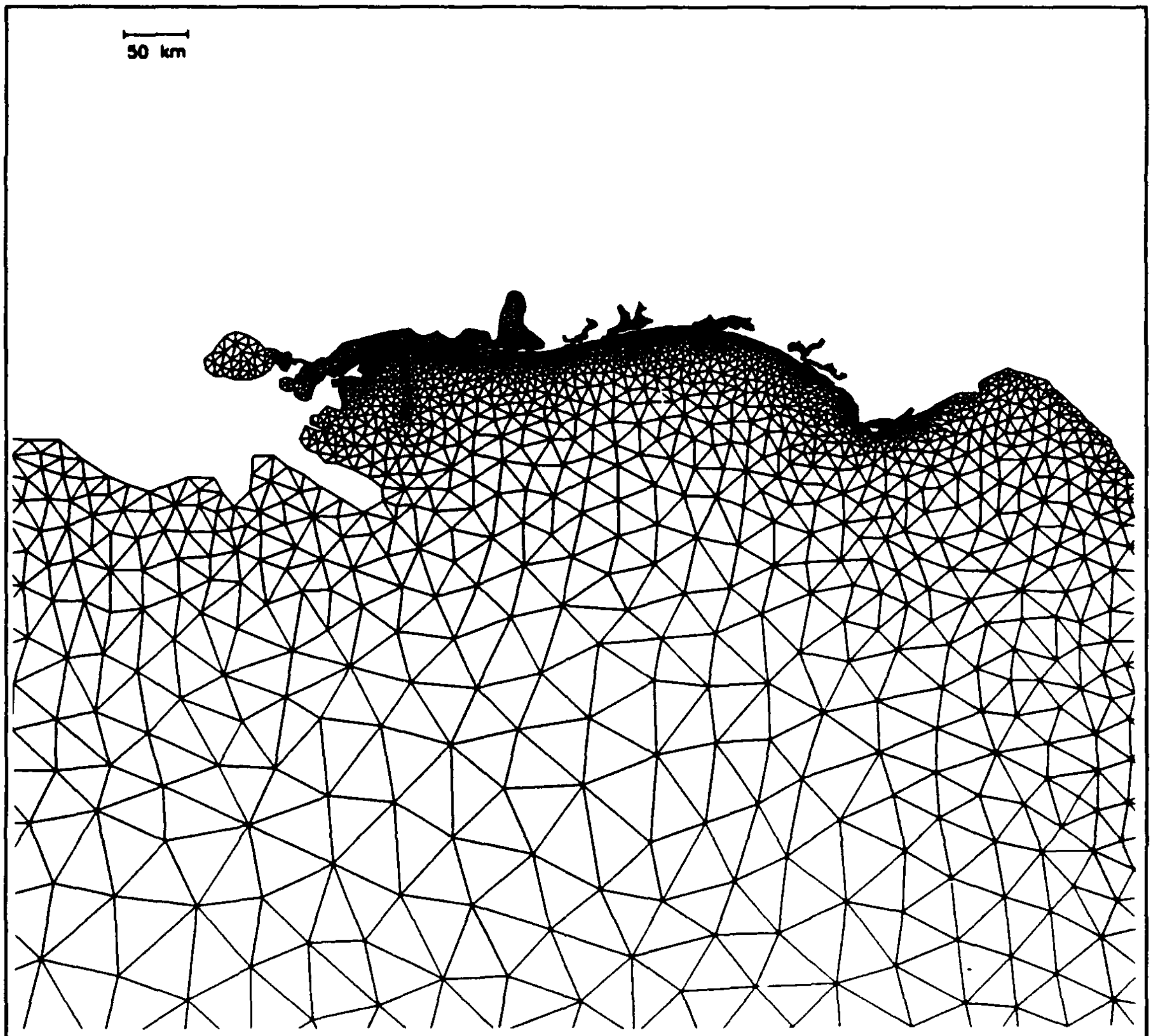


Figure 9. Finite element discretization of the Gulf of Mexico (Sheet 1 of 3)

such that $\lambda_{M_2}/\Delta x > 30$ (where λ_{M_2} is the M_2 tidal wavelength and $\Delta x \cong \sqrt{A_{elem}}$ = finite element area). The deepest parts of the Gulf are generally discretized such that $\lambda_{M_2}/\Delta x$ equals approximately 200. The region from the Mississippi Sound to St. Marks is refined to capture all the pertinent coastal features. In particular, the Mississippi Sound, Mobile Bay, Perdido Bay, and the embayments at Pensacola, Destin, Panama City, and Apalachicola are all represented in considerable detail. The level of refinement within this region is such that the $\lambda_{M_2}/\Delta x$ ratio typically varies between 100 and 500. Although the maximum to minimum element area ratio is greater than 15,000 for the final Gulf grid, the transition from large to small elements is very smooth, and adjacent element sizes are always similar. The final grid contains 6,807 elements and 3,939 nodes.

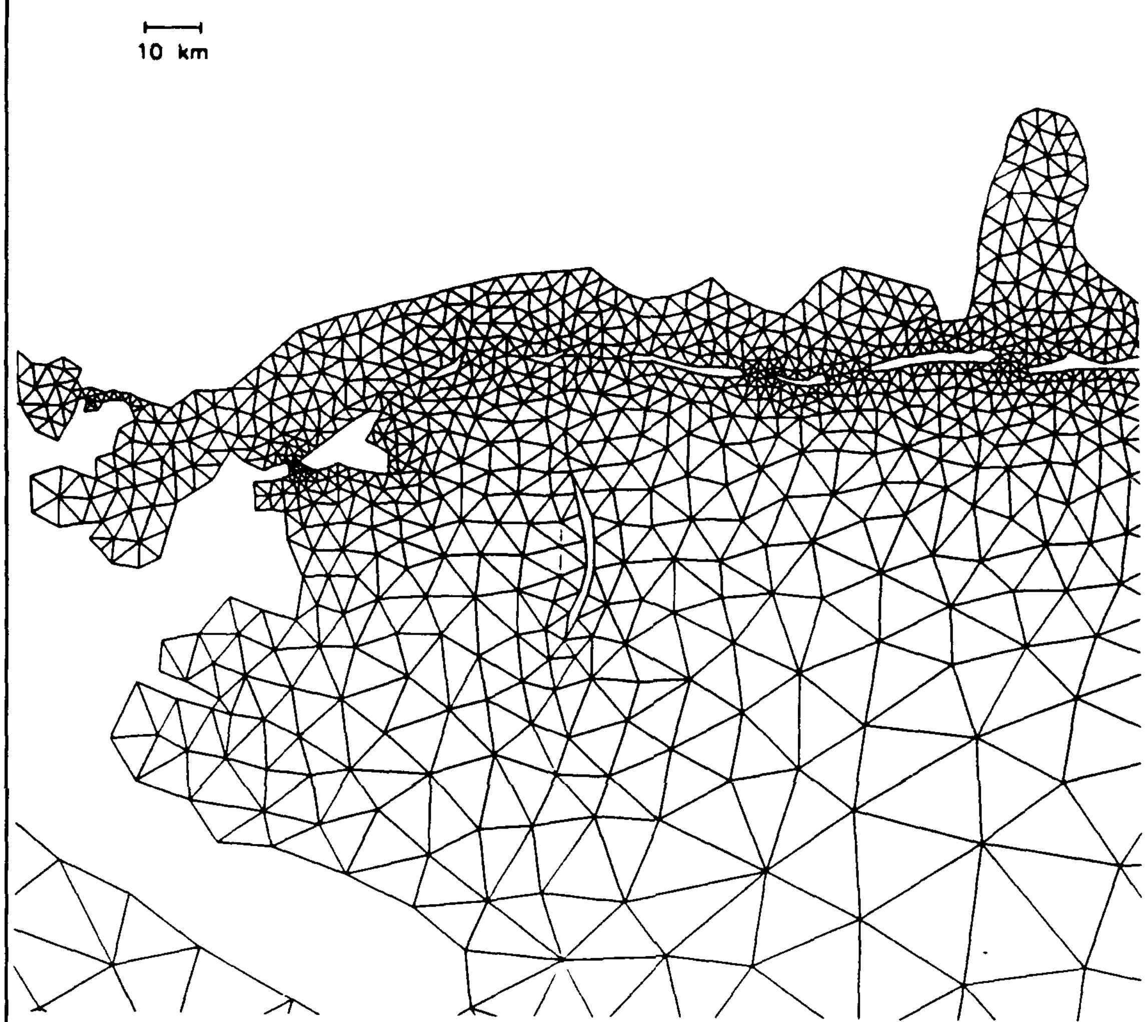


b. Detail of the coastline between the Mississippi Sound and St. Marks,

Figure 9. (Sheet 2 of 3)

Tidal Computations within the Gulf and the Mississippi Sound

Tidal simulations performed with ADCIRC-2DDI within the Gulf are compared to long-term elevation field data at 20 elevation stations throughout the Gulf (shown in Figure 8 and published by Reid and Whitaker (1981)) as well as to 20 tidal current stations throughout the Mississippi Sound (indicated in Figure 8c) as measured and analyzed by Outlaw (1983). The simulations in this study were intended to be entirely predictive; therefore, no calibration procedures were performed.



c. Detail of the Mississippi Sound

Figure 9. (Sheet 3 of 3)

Open ocean boundaries were forced with the K_1, O_1, P_1, M_2, and S_2 tidal constituents using the data listed in Table 1. An effective tidal potential forcing within the interior domain was applied for the same five constituents that were forced on the boundaries. Amplitudes for the interior domain forcing function are listed in Table 2. The theoretical value of $\alpha = 0.69$ was applied (Schwiderski 1980, Hendershott 1981) to all constituents. No nodal factors or astronomical arguments were used on either the boundary or the interior domain forcing functions.

Table 1
Tidal Forcing Constituents on the Open Ocean Boundaries (Amplitude in Meters and Phase in Degrees Relative to Greenwich)

Location	Constituent				
	K_1	O_1	P_1	M_2	S_2
Strait of Florida Havana	0.090 (8.5°)	0.101 (5.0°)	0.026 (9.7°)	0.130 (45.9°)	0.040 (69.5°)
Vicinity of Key West	0.086 (357.6)	0.089 (359.1°)	0.028 (2.0°)	0.173 (69.7)	0.053 (92.6)
Yucatan Channel	0.040 (50.0°)	0.040 (20.0°)	0.0075 (20.0°)	0.070 (35.0°)	0.040 (50.0°)

Table 2
C_{jn} Constants (in Meters) for the Tidal Potential Forcing Function (from Reid (1990))

Constituent	C_{jn}
K_1	0.141565
O_1	0.100514
P_1	0.046843
M_2	0.242334
S_2	0.112841

No lateral eddy diffusion/dispersion was used in the simulations and a constant value for the bottom friction coefficient, equal to $C_f = 0.003$, was applied throughout the domain. The bottom friction value is based on natural river channels, which are plain, clean, and straight (Chow 1959). All nonlinearities, including convective acceleration, were taken into consideration in the computations.

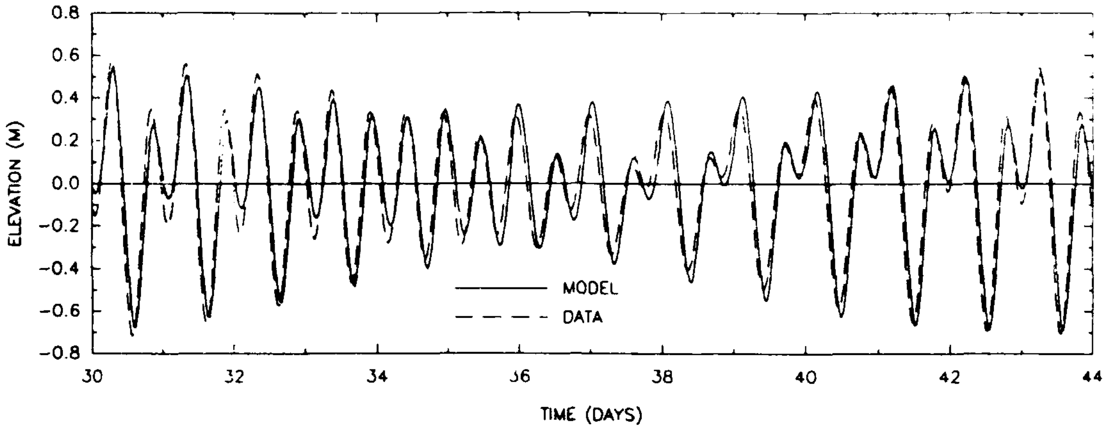
The model was spun up from homogeneous initial conditions using a time ramp to avoid problems with short-period gravity modes and vortex modes in the subinertial frequency range in addition to a free Helmholtz mode (Reid and Whitaker 1981). A very smooth hyperbolic tangent ramp function, which acts over approximately 2 days, was applied to both boundary conditions and direct forcing functions. Both significantly underdamped and correctly damped Gulf of Mexico systems were tested in order to establish spin-up requirements. Although a free Helmholtz mode was excited, its amplitude relative to the forced modes was always small due to the smoothness of the hyperbolic tangent ramp function. Estimates indicate that even for the underdamped systems, the free mode was less than 0.1 percent of the representative forced mode after only 6 days. Therefore, a 6-day spin-up was determined to be more than

adequate for all signals of interest. The actual simulation was run for 44 days. A time-step of 90 sec was used, giving a Courant number based on wave celerity ranging between approximately 0.04 and 1.56. A time-step of 180 sec led to oscillations in both elevations and velocities in the vicinity of Panama City and led to long-term instabilities. This is related to the explicit treatment of the nonlinear terms, since these problems do not arise for fully linear simulations. Time weighting factors of 0.35, 0.30, and 0.35 were used for the future, current, and past time levels in the GWCE equation and a Crank-Nicolson scheme was used for the momentum equations. The parameter τ_0 was set equal to 0.0004, which represents a balance between the primitive continuity and wave equation portions of the GWCE equation. Output at both stations and global nodes was harmonically analyzed using 22 specified constituents and time history records for the period between 14 and 44 days with sampling occurring every 30 minutes. Finally, the JCG preconditioned conjugate gradient solver from the ITPACKV 2D package was specified as the simultaneous linear algebraic equation solver.

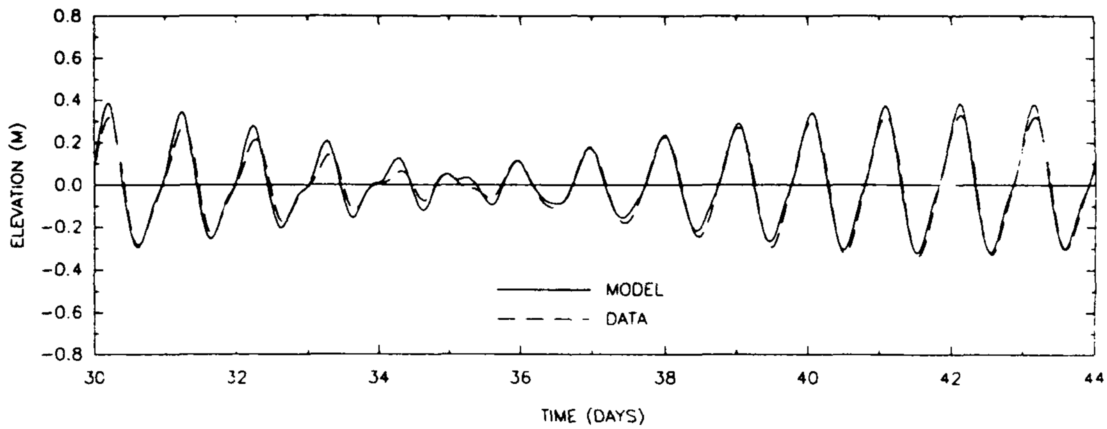
Results for the Gulf of Mexico and Mississippi Sound

The results of the simulation are compared to elevation field data at representative stations within the Gulf in Figure 10. Overall, the quality of the comparisons is good, considering that no tuning was performed in this simulation. The boundary conditions used on the Yucatan channel may not be entirely appropriate, since they are based on Reid and Whitaker's (1981) optimized linear runs, which allowed open boundary forcing functions and bottom friction as well as the effective Earth elasticity factor and an associated phase to vary (α in their computations is constituent-dependent and varies between 0.451 and 0.924). Results indicate that the tides within the Gulf are predominantly diurnal or mixed, with the exception of the tides on the west Florida Shelf, where they are strongly semidiurnal. Reid and Whitaker (1981) note that the semidiurnal tides off Florida are associated with the near resonant response to direct tidal potential forcing and they hypothesize that this response is related to the excitation of shelf edge waves. Simulations with early coarse grids indicate that it is critical to provide sufficient resolution ($\lambda_{M2}/\Delta x > 30$) over the continental shelf in order to accurately predict these large semidiurnal tides.

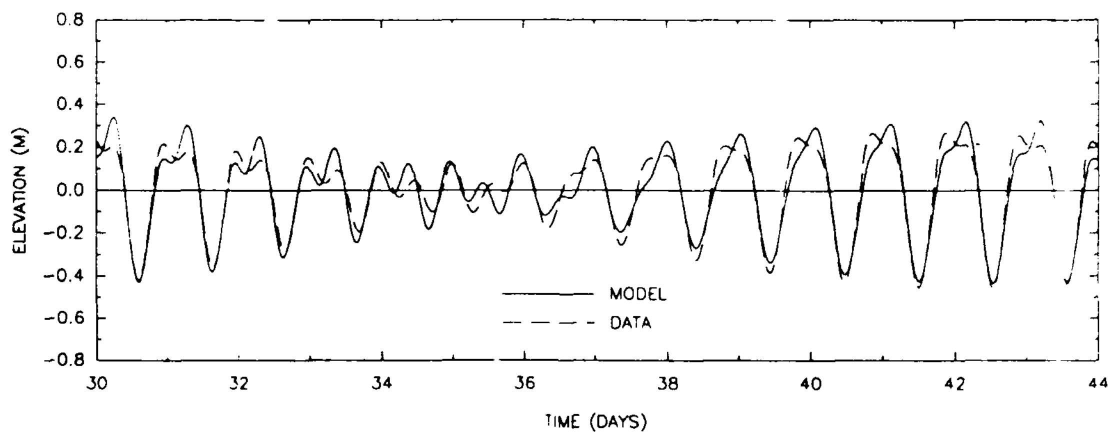
Typical comparisons between predicted and measured velocity responses within the Mississippi Sound are shown in Figure 11. The prototype measurements at the velocity stations were taken at one (mid-depth), two (surface and bottom), or three (surface, mid-depth, and bottom) depths as indicated in the figures. In general, the velocity comparisons are not as good as surface elevations. The data suggest that one factor contributing to the velocity discrepancy is that baroclinic processes, not included in these computations, play some role in determining current patterns. Experience with the model indicates that over limited shallow regions such as the Sound, velocity was much more sensitive



a. **St. Marks Light, FL**

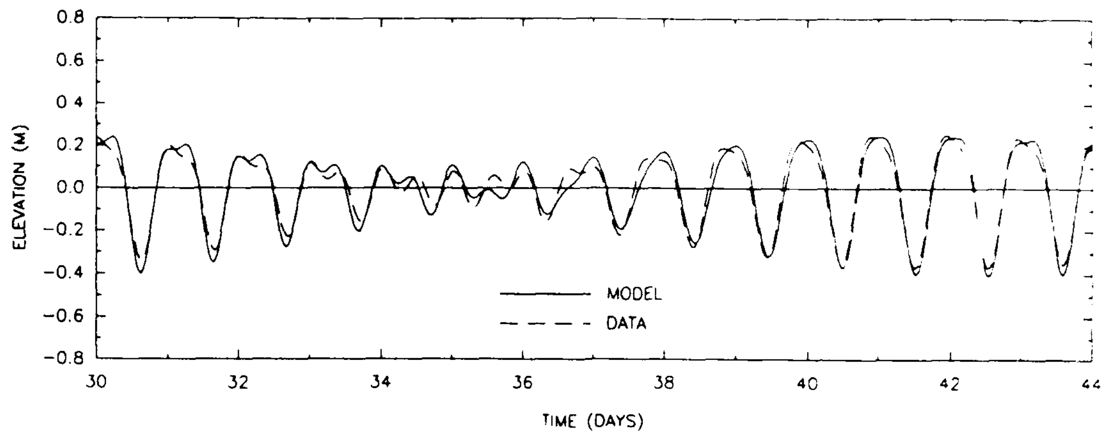


b. **Cat Island, MS**

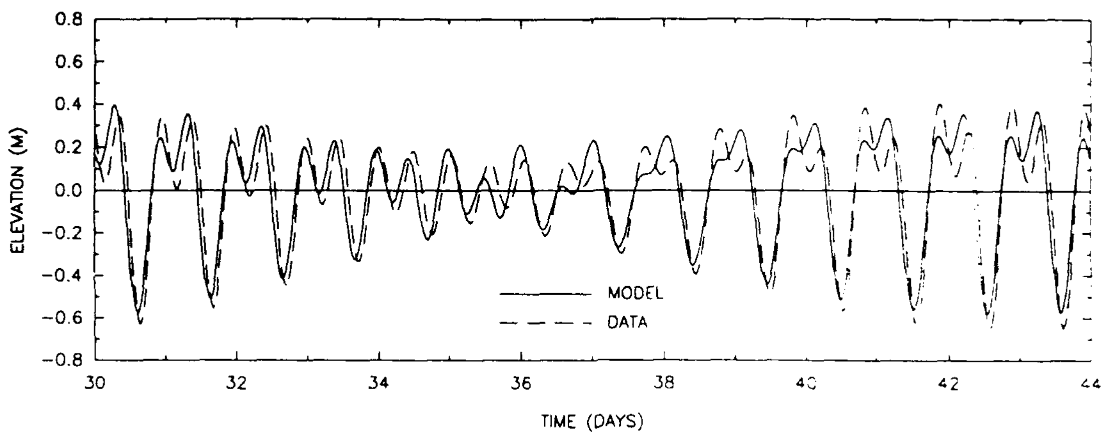


c. **Point au Fer, LA**

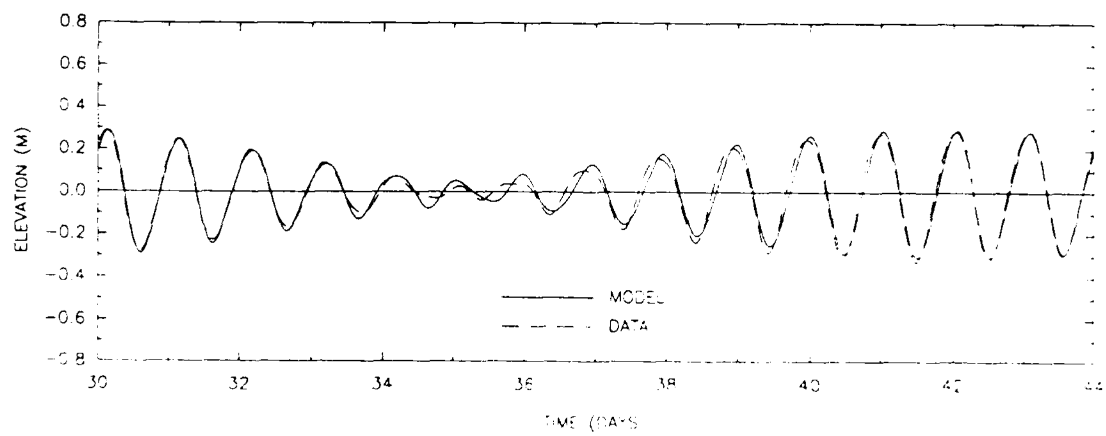
Figure 10. **Comparisons of time histories of computed surface elevations and synthesized surface elevations from harmonically decomposed measured constituent data (using K_1, O_1, P_1, M_2, and N_2) at representative tidal stations within the Gulf of Mexico (Sheet 1 of 2)**



d. **South Padre Island, TX**



e. **Campeche, Mexico**



f. **GOM Pelagic**

Figure 10. (Sheet 2 of 2)

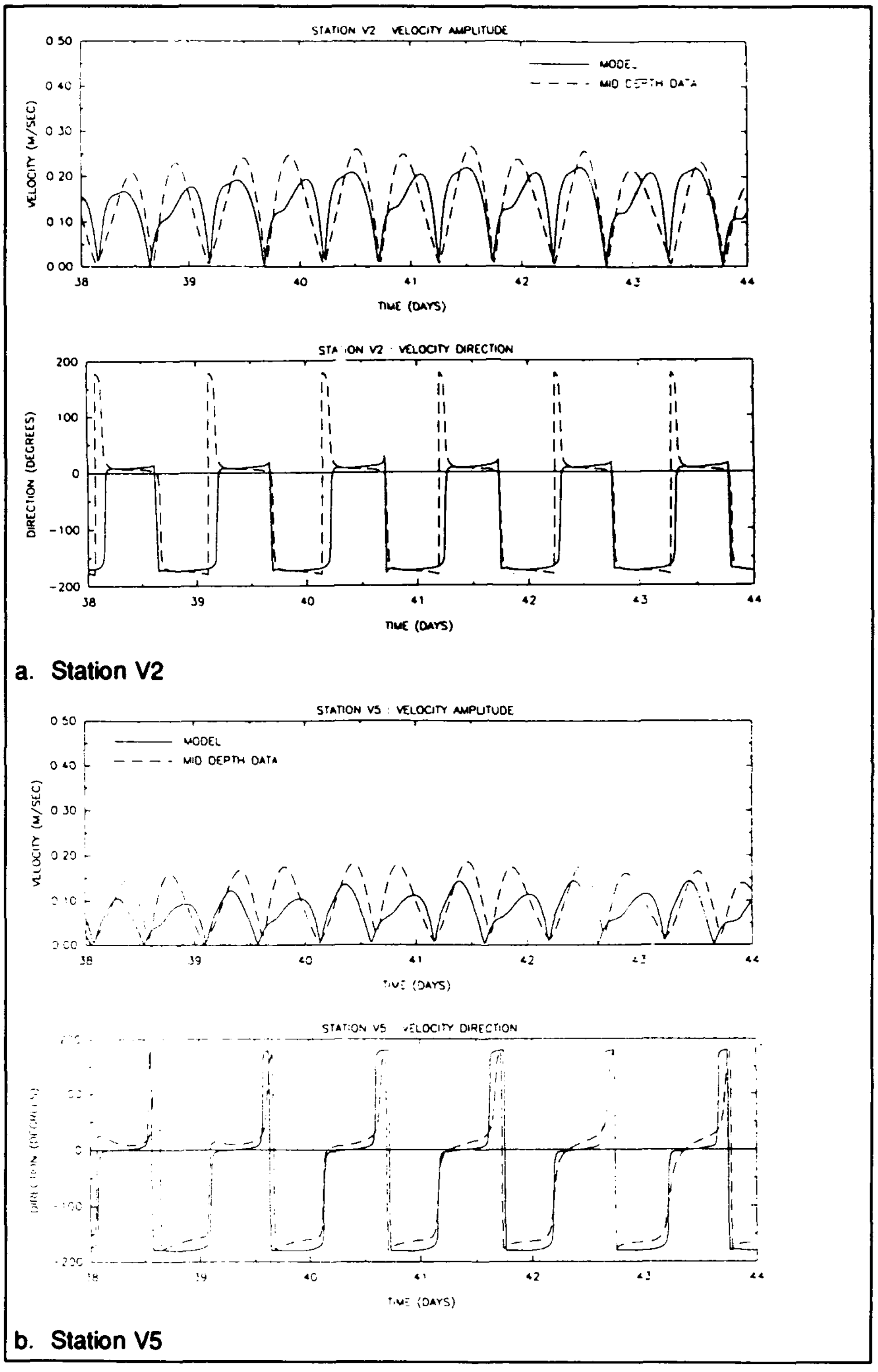
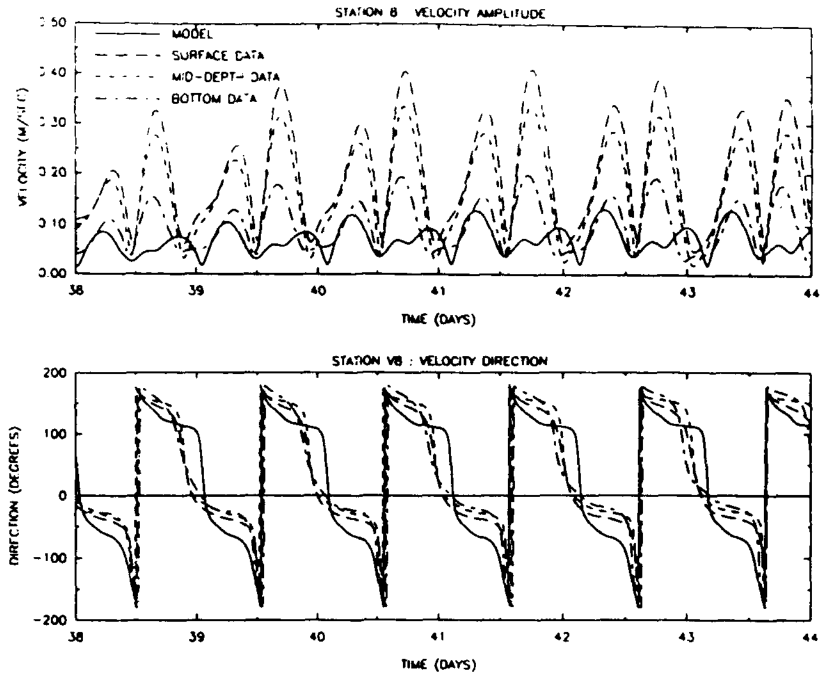
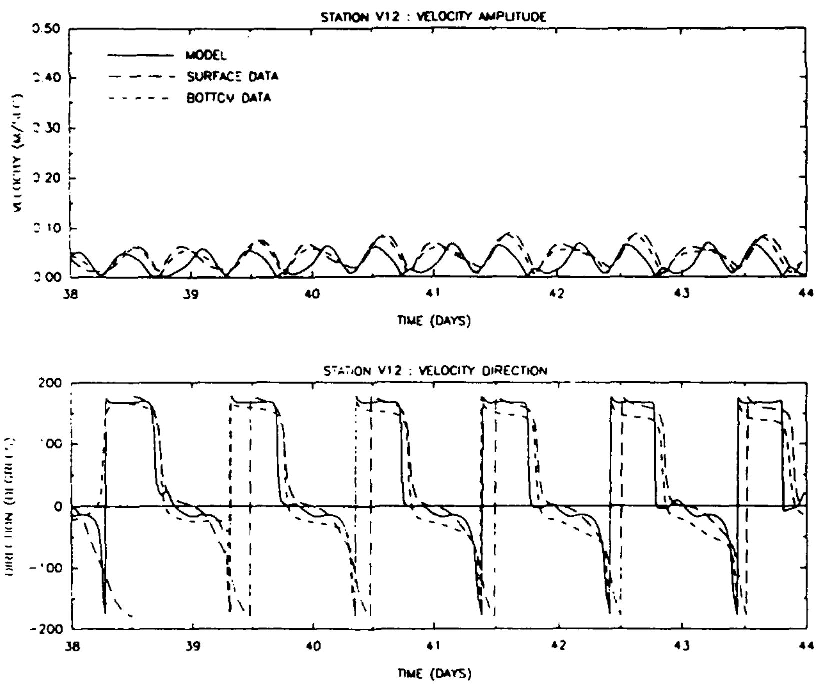


Figure 11. Comparisons of time histories of computed velocities and time histories of synthesized velocities from harmonically decomposed measured constituent data (using K_1, O_1, M_2, and N_2) at representative current stations within the Mississippi Sound (Sheet 1 of 3)

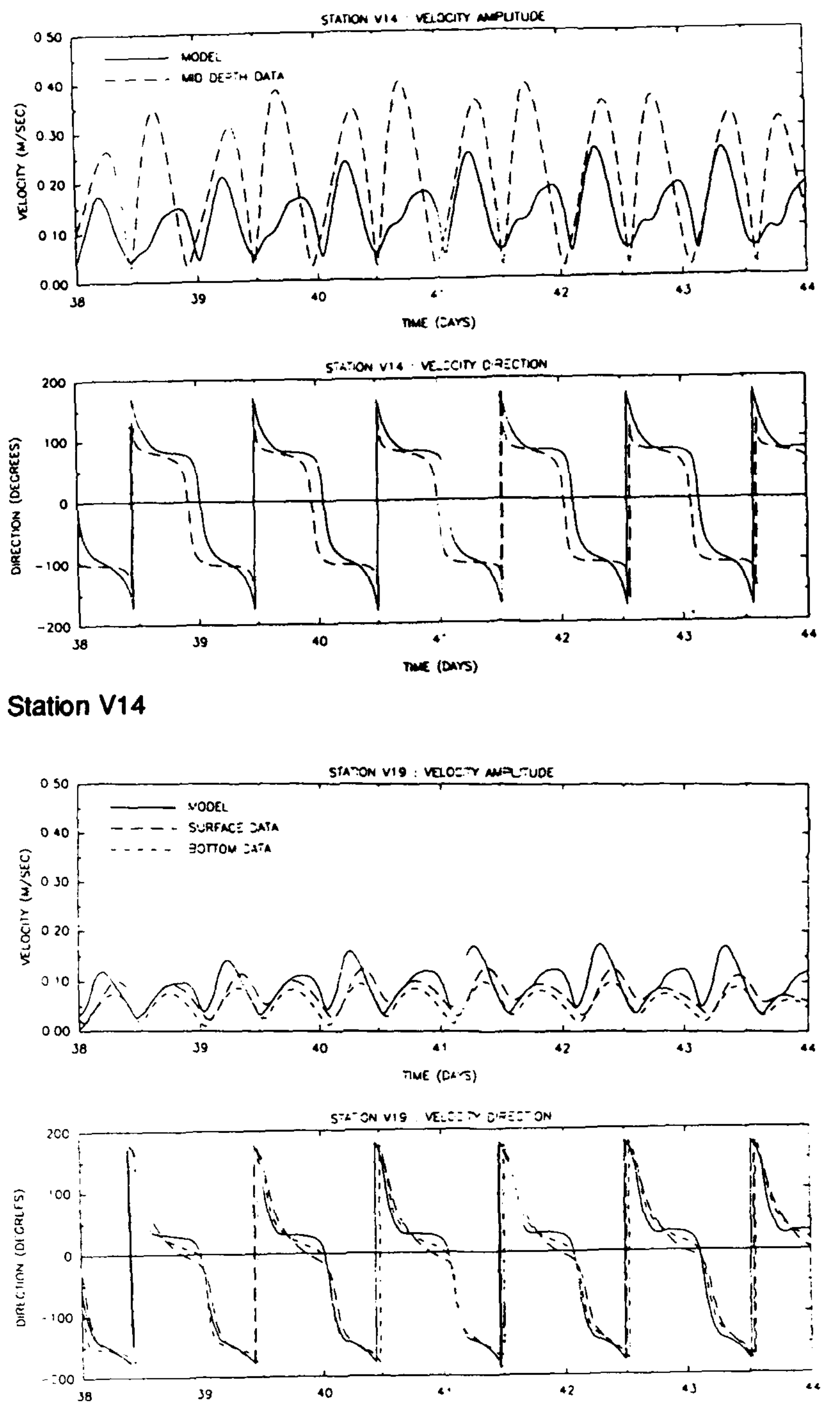


c. Station V8



d. Station V12

Figure 11. (Sheet 2 of 3)



e. Station V14

f. Station V19

Figure 11. (Sheet 3 of 3)

than elevation to the bottom friction coefficient, local geometry, and bathymetry. Model runs with coarser grids showed that the resolution of the finest grid (Figure 9) was necessary to reliably predict velocity directions. Velocity amplitudes could be made to match measurements much more closely (with minimal accompanying change in surface elevation) by adjusting the bottom friction factor within the Sound. However, to maintain the predictive theme of the simulations, these "calibration" efforts have not been pursued. Rather, the comparisons in Figure 11 were considered to indicate the typical range of predictive velocities that can be expected using a two-dimensional model with a well-resolved spatial domain.

Figures 12 and 13 present the surface elevation contours and velocity vectors (interpolated to element centroids) at TIME = 3,529,800 sec (or 39,220 time-steps into the simulation) for the Gulf produced using XMVIS. Figures 14 and 15 present the surface elevation contours and velocity vectors (interpolated to element centroids) at TIME = 3,529,800 sec (or 39,220 time-steps into the simulation) for the Mississippi Sound.

The model performance was quite good. The model ran at 2.85 CPU seconds per time-step on a SUN Sparcstation 2 and at 0.076 CPU seconds per time-step on a CRAY YMP-6128.

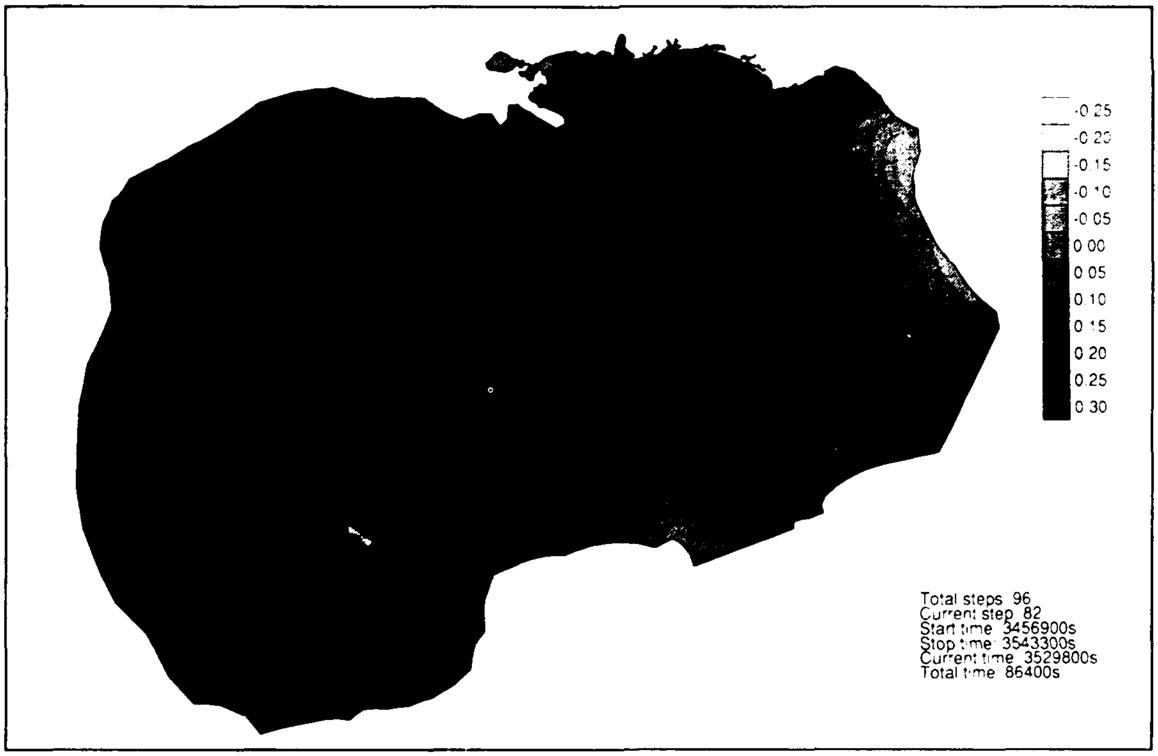


Figure 12. Surface elevation contours for the Gulf of Mexico shown using XMVIS

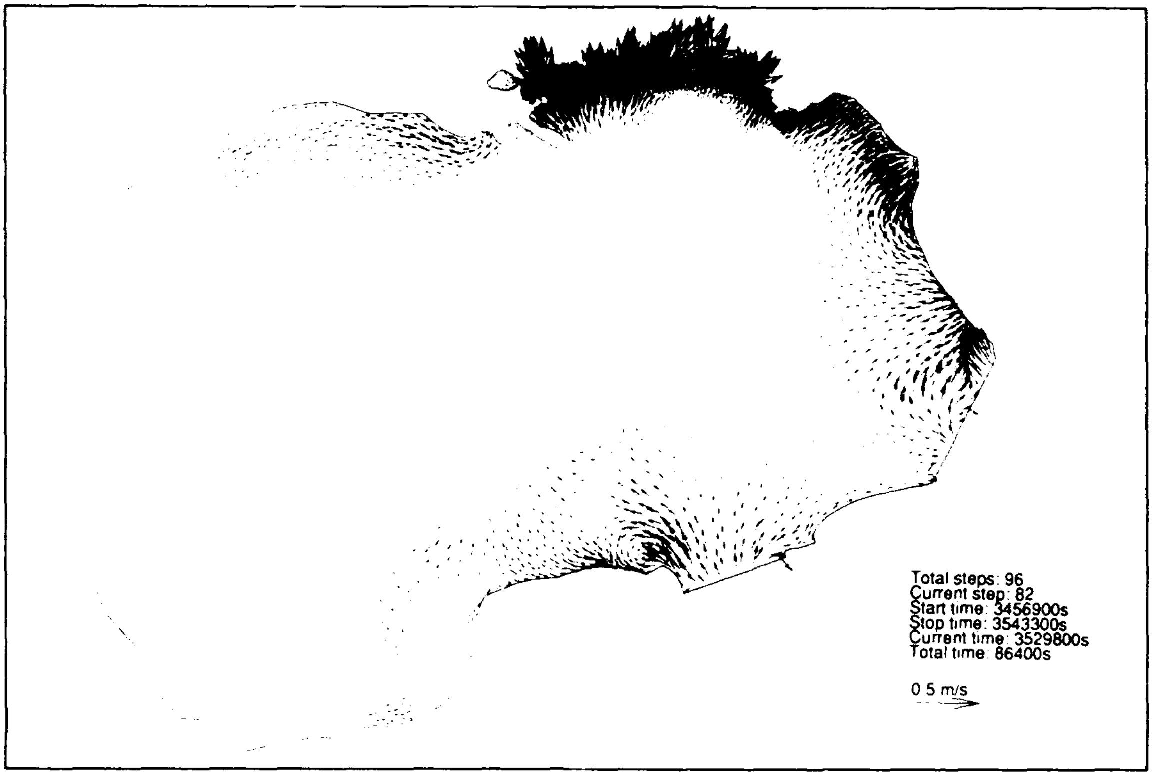


Figure 13. Velocity vector field for the Gulf of Mexico shown using XMVIS

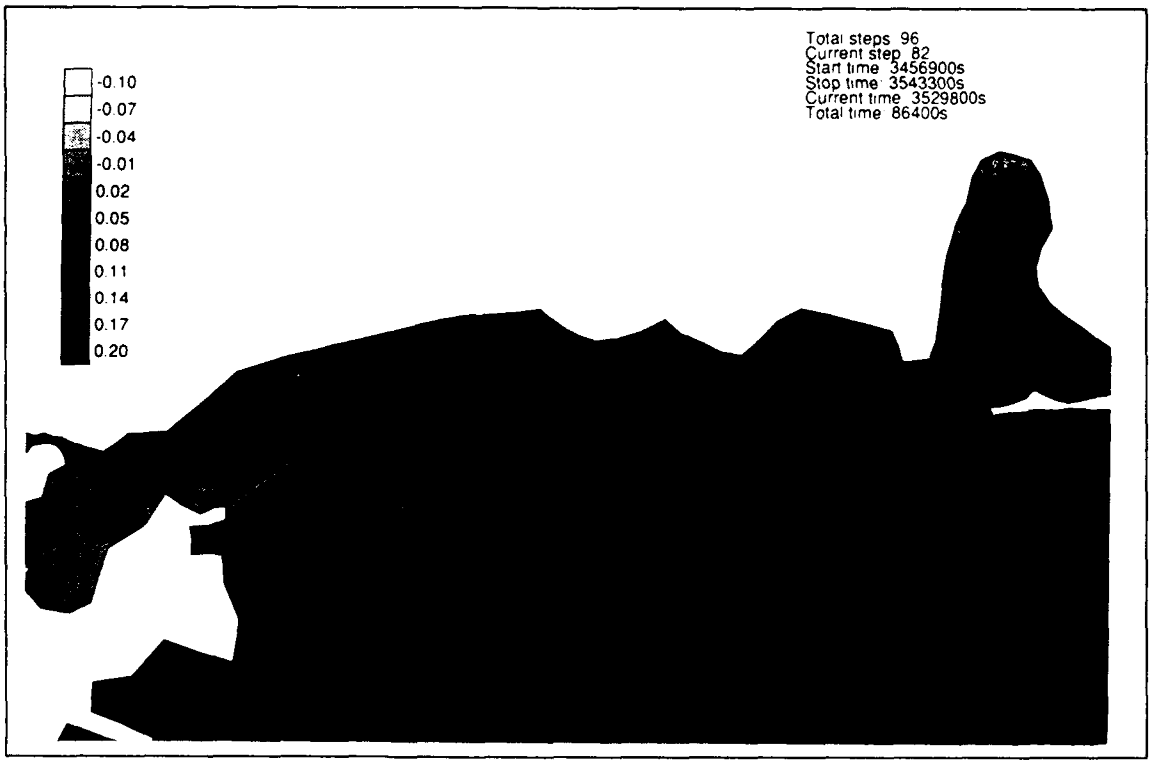


Figure 14. Surface elevation contours for the Mississippi Sound shown using XMVIS

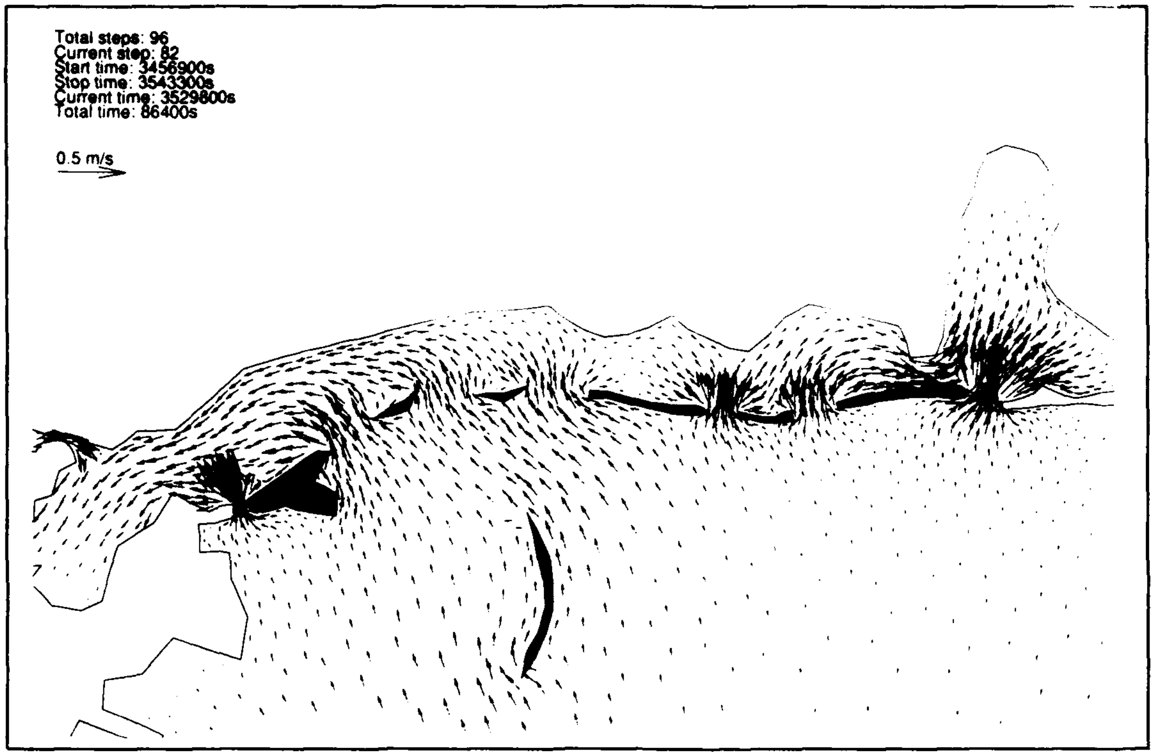


Figure 15. Velocity vector field for the Mississippi Sound shown using XMVIS

References

Baptista, A. M., and Turner, P. J. (1992). "ACE/vis users manual: Software for scientific visualization of estuarine and coastal process," Center for Coastal and Land Margin Research, Oregon Graduate Institute of Science and Technology, Beaverton, OR.

Chow, V. T. (1959). *Open channel hydraulics*. McGraw-Hill, New York.

Dongarra, J. J., Moler, C. B., Brunch, J. R., and Stewart, G. W. (1979). "LINPACK User's Guide," SIAM, Philadelphia, PA.

Drolet, J. (1989). "Application and analysis of wave formulations of the shallow water equations," Ph.D. diss. Department of Civil Engineering, Princeton University, Princeton, NJ.

Drolet, J., and Gray, W. G., (1988). "On the well posedness of some wave formulations of the shallow water equations," *Advances in Water Resources* 11, 84-91.

Foreman, M. G. G. (1977). "Manual for tidal heights analysis and prediction," Pacific Marine Science Report 77-10, Institute of Ocean Sciences, Patricia Bay, Sidney, B.C.

_________. (1983). "An analysis of the 'wave equation' model for finite element tidal computations," *Journal of Computational Physics* 52, 290-312.

_________. (1988). "A comparison of tidal models for the southwest coast of Vancouver Island." *Proceedings of the VII International Conference on Computational Methods in Water Resources*, Cambridge, MA. Elsevier Science Publishing Co., New York.

Gray, W. G. (1982). "Some inadequacies of finite element models as simulators of two-dimensional circulation," *Advances in Water Resources* 5, 171-7.

_________. (1989). "A finite element study of tidal flow data for the North Sea and English Channel," *Advances in Water Resources* 12, 143-54.

Gray, W. G., Drolet, J., and Kinnmark, I. P. E. (1987). "A simulation of tidal flow in the southern part of the North Sea and the English Channel," *Advances in Water Resources* 10, 131-7.

Hendershott, M. C. (1981). "Long waves and ocean tides." *Evolution of physical oceanography.* B. A. Warren and C. Wunsch, ed., MIT Press, Cambridge, MA, 292-341.

Kincaid, D. R., Oppe, T. C., and Young, D. M. (1989). "ITPACKV 2D users guide," Report CNA-232, Center for Numerical Analysis, The University of Texas at Austin.

Kinnmark, I. P. E. (1984). "The shallow water wave equations: Formulation, analysis, and application," Ph.D. diss., Department of Civil Engineering, Princeton University, NJ.

Kolar, R. L., and Gray, W. G. (1990). "Shallow water modelling in small water bodies." *Proceedings of the Eighth International Conference on Computational Methods in Water Resources*, 149-55.

Kolar, R. L., Gray, W. G., Westerink, J. J., and Luettich, R. A. "Shallow water modeling in spherical coordinates; Equation formulation, numerical implementation, and application, in preparation, *Journal of Hydraulic Research.*

Luettich, R. A., Westerink, J. J., and Scheffner, N. W. (1992). "ADCIRC: An advanced three-dimensional circulation model for shelves, coasts, and estuaries; Report 1: Theory and methodology of ADCIRC-2DDI and ADCIRC-3DL," Technical Report DRP-92-6, Coastal Engineering Research Center, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lynch, D. R. (1981). "Comparison of spectral and time-stepping approaches for finite element modeling of tidal circulation." *Oceans 81 Conference Record.* Vol 2; Boston, MA, September 16-18, IEEE Publ. No. 81CH1685-7.

__________. (1983). "Progress in hydrodynamic modeling, review of U.S. contributions, 1979-1982," *Reviews of Geophysics and Space Physics* 21, 741-54.

Lynch, D. R., and Gray, W. G. (1978). "Analytical solutions for computer flow model testing," *ASCE Journal of the Hydraulics Division* 104, 1409-28.

__________. (1979). "A wave equation model for finite element tidal computations," *Comp. Fluids* 7, 207-28.

Lynch, D. R., and Werner, F. E. (1991). "Three-dimensional hydrodynamics on finite elements, Part II: Nonlinear time-stepping model," *International Journal on Numerical Methods in Fluids* 12, 507-34.

Lynch, D. R., Werner, F. E., Cantos-Figuerola, A., and Parilla, G. (1988). "Finite element modeling of reduced-gravity flow in the Alboran Sea: Sensitivity studies." *Seminario Sobre Oceanografia Fisica del Estrecho de Gibraltar*, Madrid, 283-95.

Lynch, D. R., Werner, F. E., Molines, J. M., and Fornerino, M. (1990). "Tidal dynamics in a coupled ocean/lake system," *Estuarine, Coastal and Shelf Science* 31, 319-43.

Outlaw, D. G. (1983). "Prototype tidal data analysis for the Mississippi Sound and adjacent areas," Miscellaneous Paper CERC-83-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Pearson, F. (1990). *Map projections: Theory and applications*. CRC Press, Boca Raton, FL.

Platzman, G. W. (1981). "Some response characteristics of finite element tidal models," *Journal of Computational Physics* 40, 36-63.

Reid, R. O. (1990). "Waterlevel changes." *Handbook of coastal and ocean engineering*. J. Herbich, ed., Gulf Publishing, Houston, TX.

Reid, R. O., and Whitaker, R. E. (1981). "Numerical model for astronomical tides in the Gulf of Mexico," Technical Report for the U.S. Army Corps of Engineers, Department of Oceanography, Texas A&M University, College Station, TX.

Schureman, P. (1941). "Manual of harmonic analysis and prediction of tides," Special Publication #98, Coast and Geodetic Survey, U.S. Department of Commerce, U.S. Government Printing Office, Washington D.C.

Schwiderski, E. W. (1980). "On charting global ocean tides," *Reviews in Geophysics and Space Physics* 18, 243-68.

Turner, P. J., and Baptista, A. M. (1992). "ACE/gredit users manual: Software for semi-automatic generation of two-dimensional finite element grids," Center for Coastal and Land Margin Research, Oregon Graduate Institute of Science and Technology, Beaverton, OR.

van Ette, A. C. M., and Schoemaker, H. J. (1967). "Harmonic analyses of tides - essential features and disturbing influences." *Proceedings of the Symposium on Tides*, Monaco, 28-29 April.

Wahr, J. M. (1981). "Body tides on an elliptical, rotating, elastic and oceanless earth," *Geophysical Journal of the Royal Astronomical Society* 64, 677-703.

Walters, R. A. (1983). "Numerically induced oscillations in finite element approximations to the shallow water equations," *International Journal for Numerical Methods in Fluids*, 3, 591-604.

__________. (1984). "Finite element solution methods for circulation in estuaries." *Finite elements in water resources; Proceedings of the 5th International Conference*. J. P. Laible, et al., eds., Burlington, VT.

__________. (1987). "A model for tides and currents in the English Channel and Southern North Sea," *Advances in Water Resources* 10, 138-48.

__________. (1988). "A finite element model for tides and currents with field applications," *Comm. Applied Numerical Methods* 4, 401-11.

Walters, R. A., and Werner, F. E. (1989). "A comparison of two finite element models of tidal hydrodynamics using a North Sea data set," *Advances in Water Resources* 12(4),184-93.

Werner, F. E., and Lynch, D. R. (1987). "Field verification of wave equation tidal dynamics in the English Channel and Southern North Sea," *Advances in Water Resources* 10, 115-30.

__________. (1989). "Harmonic structure of English Channel/Southern Bight tides from a wave equation simulation," *Advances in Water Resources* 12, 121-42.

Westerink, J. J., and Gray, W. G. (1991). "Progress in surface water modeling," *Reviews in Geophysics* 29 (April supplement) 210-17.

Westerink, J.J., Luettich, R. A., Baptista, A. M., Scheffner, N. W., and Farrar, P. (1992a). "Tide and storm surge predictions using a finite element model," *Journal of Hydraulic Engineering* 118, 1372-90.

Westerink, J. J., Muccino, J. C., and Luettich, R. A. (1992b). "Resolution requirements for a tidal model of the Western North Atlantic and Gulf of Mexico." *Proceedings of the IX International Conference on Computational Methods in Water Resources*. Elsevier, Amsterdam.

Westerink, J. J., Stolzenbach, K. D., and Connor, J. J. (1989). General spectral computations of the nonlinear shallow water tidal interactions within the Bight of Abaco, *J. Phys. Ocea.* 19, 1348-71.

Appendix A
Sample Input and Output Files for Example 1

Sample Input File for Example 1 to UNIT 14

```
PRINCE1R_V019          ! ALPHANUMERIC DESCRIPTOR FOR GRID FILE
96  63                 ! NE,NP - NUMBER OF ELEMENTS AND NUMBER OF NODAL POINTS
      1     200000.          0.        30.0   ! NODE NO., X, Y, DEPTH
      2     250000.          0.        30.0
      3     300000.          0.        30.0
      4     350000.          0.        30.0
      5     400000.          0.        30.0
      6     450000.          0.        30.0
      7     500000.          0.        30.0
      8     196157.      39018.        30.0
      9     245196.      48773.        30.0
     10     294236.      58527.        30.0
     11     343275.      68282.        30.0
     12     392314.      78036.        30.0
     13     441353.      87791.        30.0
     14     490393.      97545.        30.0
     15     184776.      76537.        30.0
     16     230970.      95671.        30.0
     17     277164.     114805.        30.0
     18     323358.     133939.        30.0
     19     369552.     153073.        30.0
     20     415746.     172208.        30.0
     21     461940.     191342.        30.0
     22     166294.     111114.        30.0
     23     207867.     138893.        30.0
     24     249441.     166671.        30.0
     25     291014.     194450.        30.0
     26     332588.     222228.        30.0
     27     374161.     250007.        30.0
     28     415735.     277785.        30.0
     29     141421.     141421.        30.0
     30     176777.     176777.        30.0
     31     212132.     212132.        30.0
     32     247487.     247487.        30.0
     33     282843.     282843.        30.0
     34     318198.     318198.        30.0
     35     353553.     353553.        30.0
     36     111114.     166294.        30.0
     37     138893.     207867.        30.0
     38     166671.     249441.        30.0
     39     194450.     291014.        30.0
     40     222228.     332588.        30.0
```

```
        41    250007.    374161.       30.0
        42    277785.    415735.       30.0
        43     76537.    184776.       30.0
        44     95671.    230970.       30.0
        45    114805.    277164.       30.0
        46    133939.    323358.       30.0
        47    153073.    369552.       30.0
        48    172208.    415746.       30.0
        49    191342.    461940.       30.0
        50     39018.    196157.       30.0
        51     48773.    245196.       30.0
        52     58527.    294236.       30.0
        53     68282.    343275.       30.0
        54     78036.    392314.       30.0
        55     87791.    441353.       30.0
        56     97545.    490393.       30.0
        57         0.    200000.       30.0
        58         0.    250000.       30.0
        59         0.    300000.       30.0
        60         0.    350000.       30.0
        61         0.    400000.       30.0
        62         0.    450000.       30.0
        63         0.    500000.       30.0
1 3 1 2 8     ! ELEMENT NUMBER, ELEM. TYPE (=3), NODAL CONNECTIVITY FOR ELEMENT
2 3 8 2 9
3 3 9 2 10
4 3 2 3 10
5 3 10 3 4
6 3 10 4 11
7 3 11 4 12
8 3 4 5 12
9 3 5 6 12
10 3 6 13 12
11 3  13 6 14
12 3 6 7 14
13 3 15 8 16
14 3 8 9 16
15 3 16 9 10
16 3 16 10 17
17 3 17 10 18
18 3 10 11 18
19 3 18 11 12
20 3 18 12 19
21 3 19 12 20
22 3 12 13 20
23 3 20 13 14
24 3 20 14 21
25 3 22 15 16
26 3 22 16 23
27 3 23 16 24
```

```
28 3 16 17 24
29 3 24 17 18
30 3 24 18 25
31 3 25 18 26
32 3 18 19 26
33 3 26 19 20
34 3 26 20 27
35 3 27 20 28
36 3 20 21 28
37 3 29 22 30
38 3 22 23 30
39 3 30 23 24
40 3 30 24 31
41 3 31 24 32
42 3 24 25 32
43 3 32 25 26
44 3 32 26 33
45 3 33 26 34
46 3 26 27 34
47 3 34 27 28
48 3 34 28 35
49 3 36 29 30
50 3 36 30 37
51 3 37 30 38
52 3 30 31 38
53 3 38 31 32
54 3 38 32 39
55 3 39 32 40
56 3 32 33 40
57 3 33 34 40
58 3 40 34 41
59 3 41 34 42
60 3 34 35 42
61 3 43 36 44
62 3 36 37 44
63 3 44 37 38
64 3 44 38 45
65 3 45 38 46
66 3 38 39 46
67 3 39 40 46
68 3 46 40 47
69 3 47 40 48
70 3 40 41 48
71 3 41 42 48
72 3 48 42 49
73 3 50 43 44
74 3 50 44 51
75 3 51 44 52
76 3 44 45 52
77 3 45 46 52
```

```
78 3 52 46 53
79 3 53 46 54
80 3 46 47 54
81 3 54 47 48
82 3 54 48 55
83 3 55 48 56
84 3 48 49 56
85 3 57 50 58
86 3 50 51 58
87 3 58 51 52
88 3 58 52 59
89 3 59 52 60
90 3 52 53 60
91 3 60 53 54
92 3 60 54 61
93 3 61 54 62
94 3 54 55 62
95 3 62 55 56
96 3 62 56 63
 1    ! NOPE - TOTAL NUMBER OF OPEN BOUNDARY FORCING SEGMENTS
 9    ! NETA - TOTAL NUMBER OF OPEN BOUNDARY FORCING NODES
 9    ! NUMBER OF NODES ON OPEN BOUNDARY FORCING SEGMENT 1
  7   ! BEGINNING NODE NUMBER ON OPEN BOUNDARY 1
 14
 21
 28
 35
 42
 49
 56
 63   ! ENDING NODE NUMBER ON OPEN BOUNDARY 1
1     ! NBOU - TOTAL NUMBER OF LAND BOUNDARY SEGMENTS INCLUDING ISLAND SEGMENTS
21    ! NVEL - TOTAL NUMBER OF LAND BOUNDARY NODES
21 0  ! NUMBER OF NODES IN LAND BOUNDARY NO. 1 AND BOUNDARY TYPE (MAINLAND)
 63   ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 1
 62
 61
 60
 59
 58
 57
 50
 43
 36
 29
 22
 15
  8
  1
  2
```

```
3
4
5
6
7  ! END NODE NUMBER OF BOUNDARY 1
```

Sample Input File for Example 1 to UNIT 15

```
QUARTER ANNULAR TEST EXAMPLE 1    ! 32 CHARACTER ALPHANUMERIC RUN DESCRIPTION
S-0001-v24.16            ! 24 CHARACTER ALPANUMERIC RUN IDENTIFICATION
0  ! NFOVER - NONFATAL ERROR OVERRIDE OPTION
0  ! NABOUT - ABREVIATED OUTPUT OPTION PARAMETER
1  ! NSCREEN - UNIT 6 OUTPUT OPTION PARAMETER
0  ! IHOT - HOT START PARAMETER
1  ! ICS - COORDINATE SYSTEM SELECTION PARAMETER
0  ! IM - MODEL SELECTION PARAMETER IHOT
0  ! NOLIBF - BOTTOM FRICTION TERM SELECTION PARAMETER
0  ! NOLIFA - FINITE AMPLITUDE TERM SELECTION PARAMETER
0  ! NOLICA - SPATIAL DERIVATIVE CONVECTIVE SELECTION PARAMETER
0  ! NOLICAT - TIME DERIVATIVE CONVECTIVE TERM SELECTION PARAMETER
0  ! NWP - VARIABLE BOTTOM FRICTION AND LATERAL VISCOSITY OPTION PARAMETER
0  ! NCOR - VARIABLE CORIOLIS IN SPACE OPTION PARAMETER
0  ! NTIP - TIDAL POTENTIAL OPTION PARAMETER
0  ! NWS - WIND STRESS AND BAROMETRIC PRESSURE OPTION PARAMETER
1  ! NRAMP - RAMP FUNCTION OPTION
32.2         ! G - ACCELERATION DUE TO GRAVITY - DETERMINES UNITS
0.0001       ! TAU0 - WEIGHTING FACTOR IN GWCE
174.6562500  ! DT - TIME STEP (IN SECONDS)
0.00         ! STATIM - STARTING TIME (IN DAYS)
0.00         ! REFTIM - REFERENCE TIME (IN DAYS)
10.0         ! RNDAY - TOTAL LENGTH OF SIMULATION (IN DAYS)
2.0          ! DRAMP - DURATION OF RAMP FUNCTION (IN DAYS)
0.35 0.30 0.35  ! TIME WEIGHTING FACTORS FOR THE GWCE EQUATION
5.0          ! H0 - MIMINMUM CUTOFF DEPTH
265.5 29.0   ! SLAM0,SFEA0 - CENTER OF CPP PROJECTION (NOT USED IF ICS=1, NTIP=0,
NCOR=0)
0.00010      ! FFACTOR - HOMOGENEOUS LINEAR OR NONLINEAR BOTTOM FRICTION COEFFICIENT
0.0          ! ESL - LATERAL EDDY VISCOSITY COEFFICIENT; IGNORED IF NWP = 1
0.0          ! CORI - CORIOLIS PARAMETER - IGNORED IF NCOR = 1
0            ! NTIF - TOTAL NUMBER OF TIDAL POTENTIAL CONSTITUENTS BEING FORCED
1            ! NBFR - TOTAL NUMBER OF FORCING FREQUENCIES ON OPEN BOUNDARIES
M2           ! CONSTITUENT. 1  ALPHA DESCRIPTOR
0.000140525700000 1.0 0.0  ! CONSTITUENT. 1 FREQ., NODAL FACTOR, EQUIL. ARG.
 M2      ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOWS
```

```
 1.00 0.00        ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 1 AT FIRST NODE
 1.00 0.00
 1.00 0.00
 1.00 0.00
 1.00 0.00
 1.00 0.00
 1.00 0.00
 1.00 0.00
 1.00 0.00        ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 1 AT LAST NODE
110.0             ! ANGINN : INNER ANGLE THRESHOLD
1 0.0 10.0  3 ! NOUTE,TOUTSE,TOUTFE,NSPOOLE:ELEV STATION OUTPUT INFO (UNIT  61)
3 ! TOTAL NUMBER OF ELEVATION RECORDING STATIONS
           264660.  40210.  ! COORD. OF ELEVATION STATION
           414059.  35062.
           167753. 291615.
1 0.0 10.0  3 ! NOUTV,TOUTSV,TOUTFV,NSPOOLV:VEL STATION OUTPUT INFO (UNIT  62)
3 ! TOTAL NUMBER OF VELOCITY RECORDING STATIONS
           264660.  40210.  ! COORD. OF VELOCITY STATION
           414059.  35062.
           167753. 291615.
1 0.0 10.0 3 ! NOUTGE,TOUTSGE,TOUTFGE,NSPOOLGE : GLOBAL ELEV OUTPUT INFO (UNIT  63)
1 0.0 10.0 3 ! NOUTGV,TOUTSGV,TOUTFGV,NSPOOLGV : GLOBAL VEL  OUTPUT INFO (UNIT  64)
1          ! NHARFR - NUMBER OF CONSTITUENTS TO BE INCLUDED IN THE HARMONIC ANALYSIS
M2         ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I = 1
0.000140518917083 1.0 0.0  ! HAFREQ(I=1),HAFF(I=1),HAFACE(I=1)
5.00  8.00  5  0.5
! THAS,THAF,NHAINC,FMV - HARMONIC ANALYSIS PARAMETERS
1 1 1 1     ! NHASE,NHASV,NHAGE,NHAGV - CONTROL HARMONIC ANALYSIS AND OUTPUT TO UNITS
                                             51,52,53,54
1 200        ! NHSTAR,NHSINC - HOT START FILE GENERATION PARAMETERS
0  0  1.E-5  25 ! ITITER, ISLDIA, CONVCR, ITMAX - ALGEBRAIC SOLUTION PARAMETERS
```

Sample Output File for Example 1 to UNIT 6

```
-----------------------------------------------------------------------------

THE INPUT PROCESS HAS NOW BEEN COMPLETED WITH THE EXCEPTION OF UNIT 22 INPUT
    WHICH WILL BE READ IN AT EACH TIME STEP

-----------------------------------------------------------------------------

NON TIME DEPENDENT COEFF AND MARTIX ASSEMBLY SECTION, INCL MATRIX CONDITIONING
```

```
THE NEIGHBOR TABLE IS BEING COMPUTED

THE NEIGHBOR TABLE IS COMPLETED
    THE MINIMUM NUMBER OF NEIGHBORS FOR ANY NODE =   3
    1+THE MAXIMUM NUMBER OF NEIGHBORS FOR ANY NODE =   9
    IN FUTURE RUNS THE PARAMETER MNEI CAN BE SET =   9


BASIC ELEMENT MATRIX SET UP - STARTING
BASIC ELEMENT MATRIX SET UP - COMPLETED


GWCE SYSTEM MATRIX SET UP - STARTS
GWCE SYSTEM MATRIX SET UP - COMPLETED


GWCE SYSTEM MATRIX ; BC INCLUSION - STARTS
GWCE SYSTEM MATRIX ; BC INCLUSION - COMPLETED

GWCE SYSTEM MATRIX LOADED INTO BAND STORAGE


GWCE SYSTEM MATRIX ; FACTORIZATION - STARTS

GWCE SYSTEM MATRIX ; FACTORIZATION - COMPLETED

THE RECIPROCAL OF THE CONDITION NUMBER OF THE GWCE MATRIX =    0.69505E-01
```

```
LIMITED RUNTIME INFORMATION SECTION


TIME STEP =        1           NUMBER OF ITERATIONS =     0
   ELMAX =  0.202E-02 AT NODE        7    SPEEDMAX =  0.158E-03 AT NODE      35
TIME STEP =        2           NUMBER OF ITERATIONS =     0
   ELMAX =  0.404E-02 AT NODE        7    SPEEDMAX =  0.626E-03 AT NODE      35
TIME STEP =        3           NUMBER OF ITERATIONS =     0
   ELMAX =  0.605E-02 AT NODE        7    SPEEDMAX =  0.139E-02 AT NODE      35
TIME STEP =        4           NUMBER OF ITERATIONS =     0
   ELMAX =  0.805E-02 AT NODE        7    SPEEDMAX =  0.241E-02 AT NODE      35
TIME STEP =        5           NUMBER OF ITERATIONS =     0
   ELMAX =  0.100E-01 AT NODE        7    SPEEDMAX =  0.367E-02 AT NODE      35
TIME STEP =        6           NUMBER OF ITERATIONS =     0
   ELMAX =  0.120E-01 AT NODE        7    SPEEDMAX =  0.512E-02 AT NODE      35
```

```
TIME STEP =        7           NUMBER OF ITERATIONS =    0
   ELMAX =  0.139E-01 AT NODE       7    SPEEDMAX =  0.673E-02 AT NODE     35
TIME STEP =        8           NUMBER OF ITERATIONS =    0
   ELMAX =  0.159E-01 AT NODE       7    SPEEDMAX =  0.845E-02 AT NODE     35
TIME STEP =        9           NUMBER OF ITERATIONS =    0
   ELMAX =  0.177E-01 AT NODE       7    SPEEDMAX =  0.103E-01 AT NODE     35
TIME STEP =       10           NUMBER OF ITERATIONS =    0
   ELMAX =  0.196E-01 AT NODE       7    SPEEDMAX =  0.121E-01 AT NODE     35
```

This portion of the output file has been eliminated

```
 TIME STEP =    4938           NUMBER OF ITERATIONS =    0
   ELMAX =  0.102E+01 AT NODE       8    SPEEDMAX =  0.132E+01 AT NODE     35
TIME STEP =     4939           NUMBER OF ITERATIONS =    0
   ELMAX =  0.980E+00 AT NODE       8    SPEEDMAX =  0.133E+01 AT NODE     35
TIME STEP =     4940           NUMBER OF ITERATIONS =    0
   ELMAX =  0.938E+00 AT NODE       8    SPEEDMAX =  0.134E+01 AT NODE     35
TIME STEP =     4941           NUMBER OF ITERATIONS =    0
   ELMAX =  0.895E+00 AT NODE       8    SPEEDMAX =  0.135E+01 AT NODE     35
TIME STEP =     4942           NUMBER OF ITERATIONS =
   ELMAX =  0.852E+00 AT NODE       8    SPEEDMAX =  0.136E+01 AT NODE     35
TIME STEP =     4943           NUMBER OF ITERATIONS =    0
   ELMAX =  0.808E+00 AT NODE       8    SPEEDMAX =  0.137E+01 AT NODE     35
TIME STEP =     4944           NUMBER OF ITERATIONS =    0
   ELMAX =  0.764E+00 AT NODE       8    SPEEDMAX =  0.137E+01 AT NODE     35
TIME STEP =     4945           NUMBER OF ITERATIONS =    0
   ELMAX =  0.719E+00 AT NODE       8    SPEEDMAX =  0.138E+01 AT NODE     35
TIME STEP =     4946           NUMBER OF ITERATIONS =    0
   ELMAX =  0.674E+00 AT NODE       8    SPEEDMAX =  0.139E+01 AT NODE     35
TIME STEP =     4947           NUMBER OF ITERATIONS =    0
   ELMAX =  0.628E+00 AT NODE       8    SPEEDMAX =  0.139E+01 AT NODE     35
```

<u>Sample Output File for Example 1 to UNIT 16</u>

```
_______________________________________________________________________________

_______________________________________________________________________________


                    PROGRAM ADCIRC-V024    VERSION 24.16

      AN ADVANCED CIRCULATION MODEL FOR SHELVES, COASTAL SEAS AND ESTUARIES


        -  DEVELOPED FOR
```

```
          THE U.S. ARMY ENGINEERS WATERWAYS EXPERIMENT STATION
            UNDER CONTRACT WITH THE DREDGED RESEARCH PROGRAM


       -  DEVELOPED BY

          J.J. WESTERINK
            DEPARTMENT OF CIVIL ENGINEERING AND GEOLOGICAL SCIENCES
            UNIVERSITY OF NOTRE DAME

          R.A. LUETTICH, JR
            UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
            INSTITUTE OF MARINE SCIENCES
```

```
THE ADCIRC SOURCE CODE HAS BEEN CONFIGURED AS FOLLOWS:

      - 2D DEPTH INTEGRATED MODEL OPTION
      - CODE SETUP TO RUN ON A 64 BIT COMPUTER
      - CODE OPTIMIZED FOR A VECTOR COMPUTER
      - NONVECTORIZABLE PARTS OF CODE OPTIMIZED FOR SPEED
      - CODE CONFIGURED FOR A DIRECT SOLVER
```

```
RUN DESCRIPTION :  QUARTER ANNULAR TEST EXAMPLE 1

RUN IDENTIFICATION :  S-0001-v24.16
```

```
PRELIMINARY RUN INFORMATION



    NFOVER =    0
        NON-FATAL ERRORS WILL STOP EXECUTION


    NABOUT =    0
        DETAILED OUTPUT WILL BE PROVIDED TO UNIT 16 SUCH  THAT
        UNIT 14, 15, 21 AND 22 INPUT DATA WILL BE ECHO PRINTED
```

```
    NSCREEN =  1
        SCREEN OUTPUT WILL BE PROVIDED TO UNIT 6
```

```
GENERAL RUN INFORMATION



    THE MODEL WILL BE COLD STARTED FROM REST

    ICS =  1
        GOVERNING EQUATIONS ARE BASED ON STANDARD CARTESIAN COORDINATES

    NOLIBF =   0
        BOTTOM FRICTION TERM SELECTION :  LINEAR BOTTOM FRICTION

    NOLIFA =   0
        FINITE AMPLITUDE TERM SELECTION :  TURNED OFF

    NOLICA =   0
        SPATIAL DERIVATIVE COMPONENTS OF THE CONVECTIVE
        ACCELERATION TERMS :  TURNED OFF

    NOLICAT =   0
        TIME DERIVATIVE COMPONENTS OF THE CONVECTIVE
        ACCELERATION TERMS IN THE GWCE :  TURNED OFF

    NWP =  0
        A CONSTANT BOTTOM FRICTION AND EDDY VISCOSITY VALUE WILL BE USED
        THROUGHOUT THE DOMAIN

    NCOR =  0
        A CONSTANT VALUE OF THE CORIOLIS PARAMETER WILL BE USED
        THROUGHOUT THE DOMAIN

    NTIP =  0
        TIDAL POTENTIAL FORCING IS NOT USED IN THIS COMPUTATION

    NWS =  0
        NO WIND STRESS OR SURFACE PRESSURE ARE APPLIED IN THIS COMPUTATION

    NRAMP =  1
        A HYPERBOLIC TANGENT RAMP IS APPLIED TO THE FORCING FUNCTIONS
```

```
GRAVITATIONAL CONSTANT G =  32.20000


WEIGHTING COEFFICIENT FOR THE GENERALIZED WAVE CONTINUITY EQUATION :
TAU0 = 0.10000000E-03  1/sec
```

```
TIME INTEGRATION INFORMATION


    TIME STEP =  174.656250     SECONDS

    STARTING TIME FOR SIMULATION =       0.000000 DAYS

    REFERENCE TIME FOR SIMULATION =       0.000000 DAYS

    TOTAL LENGTH OF NUMERICAL SIMULATION =     10.0000     DAYS

    NUMBER OF TIME STEPS  =    4947


    VALUE FOR DRAMP USED IN RAMP EVALUATION =      2.0000     DAYS
```

DAYS OF SIMULATION	TIME	RAMP
0.00	0.00	0.0000000
0.50	0.50	0.4621172
1.00	1.00	0.7615942
1.50	1.50	0.9051483
2.00	2.00	0.9640276
2.50	2.50	0.9866143
3.00	3.00	0.9950548
4.00	4.00	0.9993293
5.00	5.00	0.9999092
6.00	6.00	0.9999877
7.00	7.00	0.9999983
8.00	8.00	0.9999998
9.00	9.00	1.0000000
10.00	10.00	1.0000000
11.00	11.00	1.0000000
12.00	12.00	1.0000000
13.00	13.00	1.0000000
14.00	14.00	1.0000000
15.00	15.00	1.0000000
16.00	16.00	1.0000000
17.00	17.00	1.0000000
18.00	18.00	1.0000000

```
                19.00          19.00         1.0000000
                20.00          20.00         1.0000000


    TIME WEIGHTING FACTORS IN THE WAVE EQUATION :

        AT TIME LEVEL K+1 :  0.35000
        AT TIME LEVEL K   :  0.30000
        AT TIME LEVEL K-1 :  0.35000
```

```
THE INPUT GRID INFORMATION IS AS FOLLOWS :


    GRID IDENTIFICATION :  PRINCE1R_V019        !

    TOTAL NUMBER OF NODES =    63

    TOTAL NUMBER OF ELEMENTS =    96

    MINIMUM BATHYMETRIC VALUE =      5.0000

    LATITUDE ABOUT WHICH CPP PROJECTION IS CENTERED  SLAM0 =  265.5000 DEGREES
    LONGITUDE ABOUT WHICH CPP PROJECTION IS CENTERED  SFEA0 =   29.0000 DEGREES


NODAL COORDINATES AND BATHYMETRY :
```

NODE NO.	X	Y	DP
1	200000.00	0.00	30.00
2	250000.00	0.00	30.00
3	300000.00	0.00	30.00
4	350000.00	0.00	30.00
5	400000.00	0.00	30.00
6	450000.00	0.00	30.00
7	500000.00	0.00	30.00
8	196157.00	39018.00	30.00
9	245196.00	48773.00	30.00
10	294236.00	58527.00	30.00
11	343275.00	68282.00	30.00
12	392314.00	78036.00	30.00
13	441353.00	87791.00	30.00
14	490393.00	97545.00	30.00
15	184776.00	76537.00	30.00
16	230970.00	95671.00	30.00
17	277164.00	114805.00	30.00

18	323358.00	133939.00	30.00
19	369552.00	153073.00	30.00
20	415746.00	172208.00	30.00
21	461940.00	191342.00	30.00
22	166294.00	111114.00	30.00
23	207867.00	138893.00	30.00
24	249441.00	166671.00	30.00
25	291014.00	194450.00	30.00
26	332588.00	222228.00	30.00
27	374161.00	250007.00	30.00
28	415735.00	277785.00	30.00
29	141421.00	141421.00	30.00
30	176777.00	176777.00	30.00
31	212132.00	212132.00	30.00
32	247487.00	247487.00	30.00
33	282843.00	282843.00	30.00
34	318198.00	318198.00	30.00
35	353553.00	353553.00	30.00
36	111114.00	166294.00	30.00
37	138893.00	207867.00	30.00
38	166671.00	249441.00	30.00
39	194450.00	291014.00	30.00
40	222228.00	332588.00	30.00
41	250007.00	374161.00	30.00
42	277785.00	415735.00	30.00
43	76537.00	184776.00	30.00
44	95671.00	230970.00	30.00
45	114805.00	277164.00	30.00
46	133939.00	323358.00	30.00
47	153073.00	369552.00	30.00
48	172208.00	415746.00	30.00
49	191342.00	461940.00	30.00
50	39018.00	196157.00	30.00
51	48773.00	245196.00	30.00
52	58527.00	294236.00	30.00
53	68282.00	343275.00	30.00
54	78036.00	392314.00	30.00
55	87791.00	441353.00	30.00
56	97545.00	490393.00	30.00
57	0.00	200000.00	30.00
58	0.00	250000.00	30.00
59	0.00	300000.00	30.00
60	0.00	350000.00	30.00
61	0.00	400000.00	30.00
62	0.00	450000.00	30.00
63	0.00	500000.00	30.00

GLOBAL NODE NUMBERS FOR EACH ELEMENT :

ELEMENT	N1	N2	N3
1	1	2	8
2	8	2	9
3	9	2	10
4	2	3	10
5	10	3	4
6	10	4	11
7	11	4	12
8	4	5	12
9	5	6	12
10	6	13	12
11	13	6	14
12	6	7	14
13	15	8	16
14	8	9	16
15	16	9	10
16	16	10	17
17	17	10	18
18	10	11	18
19	18	11	12
20	18	12	19
21	19	12	20
22	12	13	20
23	20	13	14
24	20	14	21
25	22	15	16
26	22	16	23
27	23	16	24
28	16	17	24
29	24	17	18
30	24	18	25
31	25	18	26
32	18	19	26
33	26	19	20
34	26	20	27
35	27	20	28
36	20	21	28
37	29	22	30
38	22	23	30
39	30	23	24
40	30	24	31
41	31	24	32
42	24	25	32
43	32	25	26
44	32	26	33
45	33	26	34
46	26	27	34
47	34	27	28
48	34	28	35

49	36	29	30
50	36	30	37
51	37	30	38
52	30	31	38
53	38	31	32
54	38	32	39
55	39	32	40
56	32	33	40
57	33	34	40
58	40	34	41
59	41	34	42
60	34	35	42
61	43	36	44
62	36	37	44
63	44	37	38
64	44	38	45
65	45	38	46
66	38	39	46
67	39	40	46
68	46	40	47
69	47	40	48
70	40	41	48
71	41	42	48
72	48	42	49
73	50	43	44
74	50	44	51
75	51	44	52
76	44	45	52
77	45	46	52
78	52	46	53
79	53	46	54
80	46	47	54
81	54	47	48
82	54	48	55
83	55	48	56
84	48	49	56
85	57	50	58
86	50	51	58
87	58	51	52
88	58	52	59
89	59	52	60
90	52	53	60
91	60	53	54
92	60	54	61
93	61	54	62
94	54	55	62
95	62	55	56
96	62	56	63

```
BOTTOM FRICTION AND LATERAL VISCOSITY INFORMATION

    LINEAR BOTTOM FRICTION TAU =  0.00010000     1/sec

    ESL, CONSTANT EDDY VISCOSITY = 0.00000000E+00


________________________________________________________________


CORIOLIS INFORMATION

    CONSTANT CORIOLIS COEFFICIENT = 0.00000000E+00     1/SEC


________________________________________________________________


TIDAL POTENTIAL FORCING INFORMATION


TIDAL POTENTIAL IS FORCED FOR     0 CONSTITUENT(S)

________________________________________________________________


OPEN OCEAN BOUNDARY FORCING INFORMATION


    NUMBER OF BOUNDARY TIDAL FORCING CONSTITUENTS =    1

      CONSTITUENT #    FREQUENCY    NODAL FACTOR  EQU.ARG (DEG)  CONSTITUENT

            1        0.000140525700   1.0000000      0.000          M2 !


    TOTAL NUMBER OF OPEN BOUNDARY FORCING SEGMENTS =     1

    TOTAL NUMBER OF OPEN BOUNDARY FORCING NODES =     9


    TOTAL NUMBER OF NODES ON OPEN BOUNDARY SEGMENT  1  =     9
```

```
        7
       14
       21
       28
       35
       42
       49
       56
       63



    OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER   1 DESIGNATED :  M2 !
        VERIFICATION OF CONSTITUENT :   M2

             NODE           AMPL.         PHASE(DEG)

                7          1.00000          0.000
               14          1.00000          0.000
               21          1.00000          0.000
               28          1.00000          0.000
               35          1.00000          0.000
               42          1.00000          0.000
               49          1.00000          0.000
               56          1.00000          0.000
               63          1.00000          0.000
```

```
LAND BOUNDARY INFORMATION



    THE TOTAL NUMBER OF LAND BOUNDARY SEGMENTS =      1

    THE TOTAL NUMBER OF LAND BOUNDARY NODES =    21


    ANGINN =   110.00 DEGREES
    ALL LAND BOUNDARY NODES WITH INNER ANGLES LESS THAN ANGINN WILL HAVE
        BOTH NORMAL AND TANGENTIAL COMPONENTS ZEROED



    TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   1  -     21
    THIS SEGMENT IS A MAINLAND BOUNDARY WITH SLIP
```

```
     63  THE INNER ANGLE, COS & SIN- ********   -0.10000000E+01   0.00000000E+00
     62  THE INNER ANGLE, COS & SIN-   180.00   -0.10000000E+01   0.00000000E+00
     61  THE INNER ANGLE, COS & SIN-   180.00   -0.10000000E+01   0.00000000E+00
     60  THE INNER ANGLE, COS & SIN-   180.00   -0.10000000E+01   0.00000000E+00
     59  THE INNER ANGLE, COS & SIN-   180.00   -0.10000000E+01   0.00000000E+00
     58  THE INNER ANGLE, COS & SIN-   180.00   -0.10000000E+01   0.00000000E+00
         57     THE INNER ANGLE -    95.63 BOTH NORMAL AND TANGENTIAL ARE ZEROED
     50  THE INNER ANGLE, COS & SIN-   191.25   -0.19508840E+00  -0.98078566E+00
     43  THE INNER ANGLE, COS & SIN-   191.25   -0.38268189E+00  -0.92388017E+00
     36  THE INNER ANGLE, COS & SIN-   191.25   -0.55557818E+00  -0.83146430E+00
     29  THE INNER ANGLE, COS & SIN-   191.25   -0.70710678E+00  -0.70710678E+00
     22  THE INNER ANGLE, COS & SIN-   191.25   -0.83146430E+00  -0.55557818E+00
     15  THE INNER ANGLE, COS & SIN-   191.25   -0.92388017E+00  -0.38268189E+00
      8  THE INNER ANGLE, COS & SIN-   191.25   -0.98078566E+00  -0.19508840E+00
          1     THE INNER ANGLE -    95.63 BOTH NORMAL AND TANGENTIAL ARE ZEROED
      2  THE INNER ANGLE, COS & SIN-   180.00    0.00000000E+00  -0.10000000E+01
      3  THE INNER ANGLE, COS & SIN-   180.00    0.00000000E+00  -0.10000000E+01
      4  THE INNER ANGLE, COS & SIN-   180.00    0.00000000E+00  -0.10000000E+01
      5  THE INNER ANGLE, COS & SIN-   180.00    0.00000000E+00  -0.10000000E+01
      6  THE INNER ANGLE, COS & SIN-   180.00    0.00000000E+00  -0.10000000E+01
      7  THE INNER ANGLE, COS & SIN- ********    0.00000000E+00  -0.10000000E+01

---------------------------------------------------------------------------------

OUTPUT INFORMATION WILL BE PROVIDED AS FOLLOWS :


ELEVATION RECORDING STATION OUTPUT :

    NOUTE -  1

    DATA RECORDS WILL START AFTER TOUTSE -    0.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR        0 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFE -  10.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR     4947 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 61 EVERY NSPOOLE -       3 TIME STEPS

    UNIT 61 FORMAT WILL BE ASCII


    NUMBER OF INPUT ELEVATION RECORDING STATIONS -     3

      STATION #   ELEMENT         X              Y

         1            3       264660.00        40210.00
```

```
      2            9       414059.00        35062.00
      3           66       167753.00       291615.00



VELOCITY RECORDING STATION OUTPUT :

    NOUTV =  1

    DATA RECORDS WILL START AFTER TOUTSV =   0.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR        0 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFV =  10.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR     4947 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 62 EVERY  NSPOOLV =       3 TIME STEPS

    UNIT 62 FORMAT WILL BE ASCII



    NUMBER OF INPUT VELOCITY RECORDING STATIONS =     3

      STATION #    ELEMENT          X              Y

      1            3       264660.00        40210.00
      2            9       414059.00        35062.00
      3           66       167753.00       291615.00



GLOBAL NODAL ELEVATION INFORMATION OUTPUT :

    NOUTGE =  1

    DATA RECORDS WILL START AFTER TOUTSGE =   0.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR        0 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFGE =  10.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR     4947 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 63 EVERY NSPOOLGE =       3 TIME STEPS

    UNIT 63 FORMAT WILL BE ASCII
```

```
GLOBAL NODAL VELOCITY INFORMATION OUTPUT :

    NOUTGV =  1

    DATA RECORDS WILL START AFTER TOUTSGV =    0.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR        0 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFGV =  10.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR     4947 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 64 EVERY NSPOOLGV =       3 TIME STEPS

    UNIT 64 FORMAT WILL BE ASCII



HARMONIC ANALYSIS INFORMATION OUTPUT :

    HARMONIC ANALYSIS PERFORMED FOR    1 CONSTITUENTS


      FREQUENCY    NODAL FACTOR      EQU.ARG(DEG) CONSTITUENT

    0.000140518917   1.0000000          0.000        M2  ! HAFN

    HARMONIC ANALYSIS WILL START AFTER THAS =   4.999 DAY(S) RELATIVE
        TO THE STARTING TIME OR     2473 TIME STEPS INTO THE SIMULATION

    HARMONIC ANALYSIS WILL STOP AFTER THAF =   7.999 DAY(S) RELATIVE
        TO THE STARTING TIME OR     3957 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE ANALYZED EVERY NHAINC =       5 TIME STEPS.

    MEANS AND VARIANCES WILL BE COMPUTED FOR THE FINAL   50.00000 %
        OF THE HARMONIC ANALYSIS PERIOD OR AFTER      3215 TIME STEPS INTO THE
                                            SIMULATION.
         RESULTS ARE WRITTEN TO UNIT 55.


    STATION ELEVATION HARMONIC ANAL WILL BE WRITTEN TO UNIT 51


    STATION VELOCITY HARMONIC ANAL WILL BE WRITTEN TO UNIT 52
```

```
   GLOBAL ELEVATION HARMONIC ANAL WILL BE WRITTEN TO UNIT 53


   GLOBAL VELOCITY HARMONIC ANAL WILL BE WRITTEN TO UNIT 54



HOT START OUTPUT INFORMATION OUTPUT :

   HOT START OUTPUT WILL BE WRITTEN TO UNIT 67 OR 68 EVERY   200 TIME STEPS


SOLVER INFORMATION OUTPUT :

   THE BANDED DIRECT SOLVER WILL BE USED

   MAXIMUM NODAL POINT DIFFERENCE AND HALF BANDWIDTH NBW =      8


-------------------------------------------------------------------------------

NON TIME DEPENDENT COEFF AND MARTIX ASSEMBLY SECTION, INCL MATRIX CONDITIONING


THE NEIGHBOR TABLE IS BEING COMPUTED

THE NEIGHBOR TABLE IS COMPLETED
   THE MINIMUM NUMBER OF NEIGHBORS FOR ANY NODE =   3
   1+THE MAXIMUM NUMBER OF NEIGHBORS FOR ANY NODE =   9
   IN FUTURE RUNS THE PARAMETER MNEI CAN BE SET =   9


THE RECIPROCAL OF THE CONDITION NUMBER OF THE GWCE MATRIX =    0.69505E-01




-------------------------------------------------------------------------------


LIMITED RUNTIME INFORMATION SECTION


HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =   200 TIME =  0.34931250E+05
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =   400 TIME =  0.69862500E+05
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =   600 TIME =  0.10479375E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =   800 TIME =  0.13972500E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  1000 TIME =  0.17465625E+06
```

```
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  1200 TIME =  0.20958750E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  1400 TIME =  0.24451875E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  1600 TIME =  0.27945000E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  1800 TIME =  0.31438125E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  2000 TIME =  0.34931250E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  2200 TIME =  0.38424375E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  2400 TIME =  0.41917500E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  2600 TIME =  0.45410625E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  2800 TIME =  0.48903750E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  3000 TIME =  0.52396875E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  3200 TIME =  0.55890000E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  3400 TIME =  0.59383125E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  3600 TIME =  0.62876250E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  3800 TIME =  0.66369375E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  4000 TIME =  0.69862500E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  4200 TIME =  0.73355625E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  4400 TIME =  0.76848750E+06
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  4600 TIME =  0.80341875E+06
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =  4800 TIME =  0.83835000E+06


    THE LARGEST VALUES OF THE RATIO RESYNTHESIZED TIME SERIES/RAW TIME SERIES:

          AVERAGE ELEVATION RATIO =   0.1001397E+01 AT NODE        7
         VARIANCE ELEVATION RATIO =   0.9999967E+00 AT NODE        8
         AVERAGE U VELOCITY RATIO =   0.1002148E+01 AT NODE       21
        VARIANCE U VELOCITY RATIO =   0.1109102E+01 AT NODE       29
         AVERAGE V VELOCITY RATIO =   0.1002148E+01 AT NODE       21
        VARIANCE V VELOCITY RATIO =   0.1109102E+01 AT NODE       29


    THE LOWEST VALUES OF THE RATIO RESYNTHESIZED TIME SERIES/RAW TIME SERIES:

          AVERAGE ELEVATION RATIO =   0.1000967E+01 AT NODE        8
         VARIANCE ELEVATION RATIO =   0.9999301E+00 AT NODE        7
         AVERAGE U VELOCITY RATIO =  -0.8406826E+00 AT NODE       29
        VARIANCE U VELOCITY RATIO =   0.9999290E+00 AT NODE       22
         AVERAGE V VELOCITY RATIO =  -0.8406826E+00 AT NODE       29
        VARIANCE V VELOCITY RATIO =   0.9999290E+00 AT NODE       22
```

Sample Output File for Example 1 to UNIT 51

```
1
   0.1405189171E-03  1.0000000   0.00000000  M2 ! HAFN
3
1
  0.18723458E+01     43.0209
2
  0.13202576E+01     24.8605
3
  0.165634l0E+01     37.4894
```

Sample Output File for Example 1 to UNIT 52

```
1
   0.1405189171E-03  1.0000000   0.00000000  M2 ! HAFN
3
1
  0.50938458E+00    133.7085    0.81671586E-01    133.5873
2
  0.12202128E+01    127.7123    0.10359141E+00    128.9417
3
  0.45575351E+00    131.8663    0.79593416E+00    131.8081
```

Sample Output File for Example 1 to UNIT 53

```
1
   0.1405189171E-03  1.0000000   0.00000000  M2 ! HAFN
63
1
  0.19619094E+01     44.9547
2
  0.19218847E+01     44.1062
3
  0.17893816E+01     41.0487
4
  0.16178522E+01     36.2763
5
  0.13958168E+01     28.3048
```

```
6
   0.11869825E+01     16.9358
7
   0.99998970E+00    359.7820
8
   0.19688980E+01     45.0986
9
   0.19140722E+01     43.9417
10
   0.17981239E+01     41.2481
```

This portion of the output file has been removed

```
54
   0.14033010E+01     28.5443
55
   0.11766579E+01     16.6311
56
   0.99998970E+00    359.7820
57
   0.19619094E+01     44.9547
58
   0.19218847E+01     44.1062
59
   0.17893816E+01     41.0487
60
   0.16178522E+01     36.2763
61
   0.13958168E+01     28.3048
62
   0.11869825E+01     16.9358
63
   0.99998970E+00    359.7820
```

Sample Output File for Example 1 to UNIT 54

```
1
    0.1405189171E-03  1.0000000    0.00000000  M2  ! HAFN
63
1
   0.00000000E+00      0.0000    0.00000000E+00       0.0000
2
   0.39512718E+00    134.2121    0.00000000E+00       0.0000
3
   0.72403098E+00    133.3037    0.00000000E+00       0.0000
4
   0.98259292E+00    131.4592    0.00000000E+00       0.0000
5
   0.11842363E+01    129.1367    0.00000000E+00       0.0000
6
   0.13206514E+01    125.5968    0.00000000E+00       0.0000
7
   0.13998672E+01    123.3754    0.00000000E+00       0.0000
```

```
8
  0.15655599E-06    313.0554    0.78706819E-06    133.0554
9
  0.38904500E+00    134.2954    0.77386302E-01    134.2954
10
  0.70816179E+00    133.1929    0.14086226E+00    133.1929
```

This portion of the output file has been removed

```
54
  0.23055899E+00    128.9417    0.11590996E+01    128.9417
55
  0.25982075E+00    125.5242    0.13062074E+01    125.5242
56
  0.26898346E+00    123.7067    0.13522782E+01    123.7067
57
  0.00000000E+00      0.0000    0.00000000E+00      0.0000
58
  0.00000000E+00      0.0000    0.39512718E+00    134.2121
59
  0.00000000E+00      0.0000    0.72403098E+00    133.3037
60
  0.00000000E+00      0.0000    0.98259292E+00    131.4592
61
  0.00000000E+00      0.0000    0.11842363E+01    129.1367
62
  0.00000000E+00      0.0000    0.13206514E+01    125.5968
63
  0.00000000E+00      0.0000    0.13998672E+01    123.3754
```

Sample Output File for Example 1 to UNIT 55

```
63
1
   0.50497559E-01   0.50546494E-01   0.10009691E-01    0.19147130E+01   0.19147064E+01   0.99999652E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
2
   0.50113607E-01   0.50162762E-01   0.10009809E+01    0.18355474E+01   0.18355389E+01   0.99999540E+00
  -0.89149899E-02  -0.89318632E-02   0.10018927E+01    0.78349501E-01   0.78344105E-01   0.99993114E+00
   0.00000000E+00   0.00000000E+00   0.10000000E-01    0.00000000E+00   0.00000000E+00   0.10000000E+01
3
   0.48740978E-01   0.48790747E-01   0.10010211E+01    0.15854948E+01   0.15854808E+01   0.99999114E+00
  -0.16034928E-01  -0.16065546E-01   0.10019095E+01    0.26335158E+00   0.26333378E+00   0.99993239E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
4
   0.46754813E-01   0.46805199E-01   0.10010777E+01    0.12891237E+01   0.12891030E+01   0.99998396E+00
  -0.20915436E-01  -0.20956130E-01   0.10019456E+01    0.48606171E+00   0.48603012E+00   0.99993502E+00
   0.00000000E+00   0.00000000E+00   0.10000000E-01    0.00000000E+00   0.00000000E+00   0.10000000E+01
5
   0.43578262E-01   0.43628806E-01   0.10011598E+01    0.95179487E+00   0.95176724E+00   0.99997098E+00
  -0.23886948E-01  -0.23934616E-01   0.10019956E+01    0.70787884E+00   0.70783532E+00   0.99993852E+00
```

```
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
6
   0.39738713E-01   0.39788808E-01   0.10012606E+01    0.68241439E+00   0.68238185E+00   0.99995232E+00
  -0.24310484E-01  -0.24361137E-01   0.10020836E+01    0.88374542E+00   0.88369609E+00   0.99994417E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
7
   0.34384921E-01   0.34432964E-01   0.10013972E+01    0.48258257E+00   0.48254885E+00   0.99993014E+00
  -0.24169285E-01  -0.24221205E-01   0.10021482E+01    0.99522521E+00   0.99517335E+00   0.99994790E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
8
   0.50564073E-01   0.50612969E-01   0.10009670E+01    0.19287062E+01   0.19286999E+01   0.99999671E+00
   0.34492773E-08   0.34558736E-08   0.10019124E+01    0.12316463E-13   0.12315635E-13   0.99993275E+00
  -0.17340866E-07  -0.17374028E-07   0.10019124E+01    0.31129442E-12   0.31127349E-12   0.99993275E+00
9
   0.50033463E-01   0.50082652E-01   0.10009831E+01    0.18203018E+01   0.18202930E+01   0.99999518E+00
  -0.87924805E-02  -0.88091087E-02   0.10018912E+01    0.75948612E-01   0.75943373E-01   0.99993102E+00
  -0.17489426E-02  -0.17522501E-02   0.10018912E+01    0.30050269E-02   0.30048196E-02   0.99993102E+00
10
   0.48846817E-01   0.48896571E-01   0.10010186E+01    0.16013949E+01   0.16013811E+01   0.99999143E+00
  -0.15647321E-01  -0.15677232E-01   0.10019116E+01    0.25196627E+00   0.25194928E+00   0.99993254E+00
  -0.31124479E-02  -0.31183976E-02   0.10019116E+01    0.99693476E-02   0.99686750E-02   0.99993254E+00
```

This portion of the output file has been removed

```
54
   0.43726120E-01   0.43776735E-01   0.10011576E+01    0.96224353E+00   0.96221600E+00   0.99997139E+00
  -0.46286177E-02  -0.46378751E-02   0.10020000E+01    0.26837401E-01   0.26835759E-01   0.99993882E+00
  -0.23269656E-01  -0.23316196E-01   0.10020000E+01    0.67829383E+00   0.67825233E+00   0.99993882E+00
55
   0.39443335E-01   0.39493156E-01   0.10012631E+01    0.67048126E+00   0.67044893E+00   0.99995178E+00
  -0.47731855E-02  -0.47831404E-02   0.10020856E+01    0.34208315E-01   0.34206409E-01   0.99994429E+00
  -0.23996417E-01  -0.24046463E-01   0.10020856E+01    0.86458618E+00   0.86453802E+00   0.99994429E+00
56
   0.34384921E-01   0.34432964E-01   0.10013972E+01    0.48258257E+00   0.48254885E+00   0.99993014E+00
  -0.46904097E-02  -0.47004378E-02   0.10021380E+01    0.36732706E-01   0.36730772E-01   0.99994734E+00
  -0.23580394E-01  -0.23630809E-01   0.10021380E+01    0.92839730E+00   0.92834840E+00   0.99994734E+00
57
   0.50497559E-01   0.50546494E-01   0.10009691E+01    0.19147130E+01   0.19147064E+01   0.99999652E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
58
   0.50113607E-01   0.50162762E-01   0.10009809E+01    0.18355474E+01   0.18355389E+01   0.99999540E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
  -0.89149899E-02  -0.89318632E-02   0.10018927E+01    0.78349501E-01   0.78344105E-01   0.99993114E+00
59
   0.48740978E-01   0.48790747E-01   0.10010211E+01    0.15854948E+01   0.15854808E+01   0.99999114E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
  -0.16034928E-01  -0.16065546E-01   0.10019095E+01    0.26335158E+00   0.26333378E+00   0.99993239E+00
60
   0.46754813E-01   0.46805199E-01   0.10010777E+01    0.12891237E+01   0.12891030E+01   0.99998396E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
  -0.20915436E-01  -0.20956130E-01   0.10019456E+01    0.48606171E+00   0.48603012E+00   0.99993502E+00
61
   0.43578262E-01   0.43628806E-01   0.10011598E+01    0.95179487E+00   0.95176724E+00   0.99997098E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
  -0.23886948E-01  -0.23934616E-01   0.10019956E+01    0.70787884E+00   0.70783532E+00   0.99993852E+00
62
   0.39738713E-01   0.39788808E-01   0.10012606E+01    0.68241439E+00   0.68238185E+00   0.99995232E+00
   0.00000000E+00   0.00000000E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
  -0.24310484E-01  -0.24361137E-01   0.10020836E+01    0.88374542E+00   0.88369609E+00   0.99994417E+00
63
```

```
 0.34384921E-01   0.34432964~-01   0.10013972E+01    0.48258257E+00   0.48254885E+00   0.99993014E+00
 0.00000000E+00   0.00000  0E+00   0.10000000E+01    0.00000000E+00   0.00000000E+00   0.10000000E+01
-0.24169285E-01  -0.24   1205E-01   0.10021482E+01    0.99522521E+00   0.99517335E+00   0.99994790E+00
```

Sample Output File for Example 1 to UNIT 61

```
 QUARTER ANNULAR TEST EXAMPLE 1    S-0001-v24.16            PRINCE1R_V019       !
      1649          3   0.5239688E+03     3     1
   0.5239687500000000E+03          3
0.10679114E-04 -.48312736E-03 -.52416241E-04
   0.1047937500000000E+04          6
-.84727051E-05 -.82089467E-03 0.57187201E-04
   0.1571906250000000E+04          9
-.43250970E-04 -.69026328E-03 0.25855922E-03
   0.2095875000000000E+04         12
-.27801590E-04 0.40494221E-03 0.24442705E-03
   0.2619843750000000E+04         15
0.93188809E-04 0.28938789E-02 -.25063266E-03
   0.3143812500000000E+04         18
0.26261046E-03 0.68273498E-02 -.10936039E-02
   0.3667781250000000E+04         21
0.28895027E-03 0.11780995E-01 -.16756083E-02
   0.4191750000000000E+04         24
-.23238710E-04 0.17093959E-01 -.12438477E-02
   0.4715718750000000E+04         27
-.68826928E-03 0.22239612E-01 0.64002075E-03
   0.5239687500000000E+04         30
-.14519667E-02 0.27006674E-01 0.39060348E-02
```

This portion of the output file has been removed

```
   0.8593087500000000E+06       4920
0.15241248E+01 0.78215652E+00 0.12492724E+01
   0.8598327187500000E+06       4923
0.14399881E+01 0.70179027E+00 0.11658793E+01
   0.8603566875000000E+06       4926
0.13480479E+01 0.61762096E+00 0.10761681E+01
   0.8608806562500000E+06       4929
0.12488026E+01 0.53010471E+00 0.98062505E+00
   0.8614046250000000E+06       4932
0.11427899E+01 0.43971578E+00 0.87976792E+00
   0.8619285937500000E+06       4935
0.10305843E+01 0.34694398E+00 0.77414326E+00
   0.8624525625000000E+06       4938
0.91279395E+00 0.25229207E+00 0.66432345E+00
   0.8629765312500000E+06       4941
0.79005705E+00 0.15627297E+00 0.55090361E+00
   0.8635005000000000E+06       4944
0.66303876E+00 0.59407010E-01 0.43449838E+00
   0.8640244687500000E+06       4947
0.53242740E+00 -.37780882E-01 0.31573856E+00
```

Sample Output File for Example 1 to UNIT 62

```
  QUARTER ANNULAR TEST EXAMPLE 1    S-0001-v24.16              PRINCE1R_V019        !
    1649           3   0.5239688E+03     3     2
   0.523968750000000E+03          3
0.10862076E-05 0.32384411E-06 -.80616387E-04 0.82106399E-05 -.13670482E-04 -.23908518E-04
   0.104793750000000E+04          6
0.22594560E-05 0.53131631E-06 -.41017232E-03 0.23461053E-04 -.36555202E-04 -.61666596E-04
   0.157190625000000E+04          9
-.16133174E-05 -.81879609E-06 -.12040265E-02 0.21873546E-04 -.27193937E-04 -.37851339E-04
   0.209587500000000E+04         12
-.15078933E-04 -.40963271E-05 -.26897717E-02 -.26750147E-04 0.47750312E-04 0.10265870E-03
   0.261984375000000E+04         15
-.33666986E-04 -.69079995E-05 -.49977811E-02 -.14923146E-03 0.17366584E-03 0.32375898E-03
   0.314381250000000E+04         18
-.33634805E-04 -.35232463E-05 -.81000165E-02 -.35938432E-03 0.26229754E-03 0.45978581E-03
   0.366778125000000E+04         21
0.24633950E-04 0.12359234E-04 -.11806594E-01 -.65184585E-03 0.16407299E-03 0.24558721E-03
   0.419175000000000E+04         24
0.16667325E-03 0.40622202E-04 -.15815012E-01 -.10031681E-02 -.28011029E-03 -.58994140E-03
   0.471571875000000E+04         27
0.35941169E-03 0.67910792E-04 -.19791645E-01 -.13800238E-02 -.11746630E-02 -.22152706E-02
   0.523968750000000E+04         30
0.47978150E-03 0.67261682E-04 -.23447813E-01 -.17492979E-02 -.25280009E-02 -.46302043E-02
```

This portion of the output file has been removed

```
   0.859308750000000E+06       4920
0.29089266E+00 0.46781651E-01 0.79765084E+00 0.66019841E-01 0.27215822E+00 0.47594939E+00
   0.859832718750000E+06       4923
0.32086693E+00 0.51579889E-01 0.86342204E+00 0.71713722E-01 0.29831472E+00 0.52159214E+00
   0.860356687500000E+06       4926
0.34910240E+00 0.56098611E-01 0.92451429E+00 0.77018981E-01 0.32285462E+00 0.56440834E+00
   0.860880656250000E+06       4929
0.37544605E+00 0.60313330E-01 0.98059651E+00 0.81906867E-01 0.34564495E+00 0.60416596E+00
   0.861404625000000E+06       4932
0.39975513E+00 0.64201205E-01 0.10313648E+01 0.86350892E-01 0.36656220E+00 0.64064956E+00
   0.861928593750000E+06       4935
0.42189789E+00 0.67741169E-01 0.10765440E+01 0.90326975E-01 0.38549301E+00 0.67366142E+00
   0.862452562500000E+06       4938
0.44175436E+00 0.70914038E-01 0.11158894E+01 0.93813568E-01 0.40233481E+00 0.70302265E+00
   0.862976531250000E+06       4941
0.45921692E+00 0.73702617E-01 0.11491876E+01 0.96791777E-01 0.41699631E+00 0.72857414E+00
   0.863500500000000E+06       4944
0.47419095E+00 0.76091795E-01 0.11762583E+01 0.99245463E-01 0.42939808E+00 0.75017742E+00
   0.864024468750000E+06       4947
0.48659530E+00 0.78068626E-01 0.11969548E+01 0.10116133E+00 0.43947291E+00 0.76771542E+00
```

Sample Output File for Example 1 to UNIT 63

```
QUARTER ANNULAR TEST EXAMPLE 1    S-0001-v24.16           PRINCE1R_V019         !
   1649         63   0.5239688E+03     3     1
  0.5239687500E+03              3
     1   0.11028881E-05
     2  -0.92496065E-05
     3   0.75026187E-05
     4  -0.14312338E-03
     5   0.13489286E-03
     6  -0.21569905E-02
     7   0.60479471E-02
     8   0.36404217E-05
     9  -0.22476198E-05
    10   0.37165149E-04
```

This portion of the output file has been removed

```
    54   0.54598426E-03
    55  -0.19721797E-03
    56   0.60479471E-02
    57   0.11028881E-05
    58  -0.92496065E-05
    59   0.75026187E-05
    60  -0.14312338E-03
    61   0.13489286E-03
    62  -0.21569905E-02
    63   0.60479471E-02
  0.1047937500E+04              6
     1  -0.98510302E-05
     2   0.31385714E-04
     3  -0.44014969E-04
     4   0.69017857E-04
     5  -0.48674295E-03
     6  -0.24945466E-02
     7   0.11997041E-01
     8  -0.20609471E-04
     9   0.15638007E-04
    10  -0.59678605E-04
```

This portion of the output file has been removed

```
    54   0.33469371E-03
    55   0.69489914E-03
    56   0.11997041E-01
    57  -0.98510302E-05
    58   0.31385714E-04
    59  -0.44014969E-04
    60   0.69017857E-04
    61  -0.48674295E-03
    62  -0.24945466E-02
    63   0.11997041E-01
  0.1571906250E+04              9
     1  -0.54729108E-05
     2   0.42825324E-04
     3  -0.65660631E-04
     4   0.42522304E-03
```

```
         5  -0.15045614E-02
         6  -0.13178909E-03
         7   0.17749341E-01
         8  -0.14587024E-04
         9   0.16080568E-04
        10  -0.16119626E-03
```

The remainder of this output file has been removed

Sample Output File for Example 1 to UNIT 64

```
 QUARTER ANNULAR TEST EXAMPLE 1    S-0001-v24.16             PRINCE1R_V019         !
   1649          63   0.5239688E+03      3     2
  0.5239687500E+03             3
      1   0.00000000E+00   0.00000000E+00
      2  -0.21668016E-05   0.00000000E+00
      3   0.13620416E-04   0.00000000E+00
      4  -0.29766402E-04   0.00000000E+00
      5   0.17614784E-03   0.00000000E+00
      6  -0.44883352E-03   0.00000000E+00
      7  -0.13852236E-02   0.00000000E+00
      8  -0.12461738E-11   0.62650031E-11
      9  -0.35979100E-05  -0.71564849E-06
     10   0.80191895E-05   0.15951321E-05
```

This portion of the output file has been eliminated

```
     54   0.18274071E-04   0.91870571E-04
     55  -0.87962539E-04  -0.44222283E-03
     56  -0.23757078E-03  -0.11943605E-02
     57   0.00000000E+00   0.00000000E+00
     58   0.00000000E+00  -0.21668016E-05
     59   0.00000000E+00   0.13620416E-04
     60   0.00000000E+00  -0.29766402E-04
     61   0.00000000E+00   0.17614784E-03
     62   0.00000000E+00  -0.44883352E-03
     63   0.00000000E+00  -0.13852236E-02
  0.1047937500E+04             6
      1   0.00000000E+00   0.00000000E+00
      2  -0.16460047E-05   0.00000000E+00
      3   0.24818197E-04   0.00000000E+00
      4  -0.60046017E-04   0.00000000E+00
      5   0.56947197E-03   0.00000000E+00
      6  -0.18337591E-02   0.00000000E+00
      7  -0.51174515E-02   0.00000000E+00
      8  -0.11375956E-11   0.57191377E-11
      9  -0.42727794E-05  -0.84990326E-06
     10   0.11504158E-04   0.22883542E-05
```

This portion of the output file has been eliminated

```
     54   0.52216266E-04   0.26251099E-03
     55  -0.35746749E-03  -0.17971306E-02
```

```
   56  -0.88232234E-03  -0.44357761E-02
   57   0.00000000E+00   0.00000000E+00
   58   0.00000000E+00  -0.16460047E-05
   59   0.00000000E+00   0.24818197E-04
   60   0.00000000E+00  -0.60046017E-04
   61   0.00000000E+00   0.56947197E-03
   62   0.00000000E+00  -0.18337591E-02
   63   0.00000000E+00  -0.51174515E-02
0.1571906250E+04              9
    1   0.00000000E+00   0.00000000E+00
    2   0.10009765E-04   0.00000000E+00
    3  -0.11731408E-04   0.00000000E+00
    4   0.24575551E-04   0.00000000E+00
    5   0.83088567E-03   0.00000000E+00
    6  -0.42271347E-02   0.00000000E+00
    7  -0.10255025E-01   0.00000000E+00
    8   0.46107432E-11  -0.23180009E-10
    9   0.11826541E-04   0.23523634E-05
   10  -0.23042896E-04  -0.45835174E-05
```

The remainder of this output file has been eliminated

Appendix B
Sample Input and Output Files for Example 2

<u>Sample Input File for Example 2 to UNIT 14</u>

```
gomex_gll_v018_s.grd     ! 24 CHARACTER ALPHANUMERIC GRID IDENTIFICATION
    6807      3939     ! NUMBER OF ELEMENTS AND NODE POINTS
       1 -0.85359361E+02   0.29700219E+02              3.86    ! NODE, X, Y, DEPTH
       2 -0.85350543E+02   0.29685920E+02              6.17
       3 -0.85345907E+02   0.29716501E+02              7.80
       4 -0.85372952E+02   0.29718852E+02              7.59
       5 -0.85325044E+02   0.29692192E+02              3.29
       6 -0.85327362E+02   0.29719637E+02              6.99
       7 -0.85357303E+02   0.29746508E+02              9.38
       8 -0.85333131E+02   0.29745640E+02              8.47
       9 -0.85386861E+02   0.29740814E+02              9.18
      10 -0.85304180E+02   0.29704737E+02              3.29

This portion of the input file has been eliminated

    3930 -0.90264925E+02   0.30240225E+02              0.97
    3931 -0.90262154E+02   0.30355098E+02              0.79
    3932 -0.90178641E+02   0.30390530E+02              0.51
    3933 -0.90267937E+02   0.30059118E+02              5.19
    3934 -0.90346905E+02   0.30060099E+02              2.11
    3935 -0.90353626E+02   0.30170246E+02              0.69
    3936 -0.90371303E+02   0.30231542E+02              0.71
    3937 -0.90312048E+02   0.30301848E+02              0.89
    3938 -0.90414608E+02   0.30105910E+02              0.91
    3939 -0.90431037E+02   0.30188467E+02              0.51
  1  3  3790  3757  3758     ! ELEMENT NO., ELEMENT TYPE, N1, N2, N3
  2  3  3790  3758  3759
  3  3  3757  3756  3700
  4  3  3757  3700  3758
  5  3  3758  3701  3759
  6  3  3756  3698  3699
  7  3  3758  3700  3701
  8  3  3756  3699  3700
  9  3  3698  3695  3609
  10  3  3698  3609  3699

This portion of the input file has been eliminated

  6798  3  3666  3742  3668
  6799  3  3574  3573  3669
  6800  3  3573  3668  3669
```

```
  6801  3  3742  3743  3668
  6802  3  3667  3574  3670
  6803  3  3574  3669  3670
  6804  3  3668  3744  3669
  6805  3  3668  3743  3744
  6806  3  3669  3745  3670
  6807  3  3669  3744  3745
2     ! NOPE - TOTAL NUMBER OF OPEN BOUNDARY FORCING SEGMENTS
20    ! NETA - TOTAL NUMBER OF OPEN BOUNDARY FORCING NODES
 8    ! NUMBER OF NODES ON OPEN BOUNDARY FORCING SEGMENT 1
2527 ! BEGINNING NODE NUMBER ON OPEN BOUNDARY 1 - SOUTH BOUNDARY
2398
2270
2145
2144
1988
1985
1986 ! ENDING NODE NUMBER ON OPEN BOUNDARY 1 - SOUTH BOUNDARY
12    ! NUMBER OF NODES ON OPEN BOUNDARY FORCING SEGMENT 2
2147 ! BEGINNING NODE NO. ON OPEN BOUNDARY NO. 2 - EAST BOUNDARY
2148
2149
2150
2151
2152
2153
2154
2155
2291
2292
2427  ! ENDING NODE NO. ON OPEN BOUNDARY NO. 2 - EAST BOUNDARY
13    ! NBOU -TOTAL NUMBER OF LAND BOUNDARY SEGMENTS INCLUDING ISLAND SEGMENTS
1075  ! NVEL - TOTAL NO. OF LAND BOUNDARY NODES
834 0 ! NUMBER OF NODES IN LAND BOUNDARY NO. 1 AND BOUNDARY TYPE(MAINLAND)
2427  ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 1 (MAINLAND)
2428
2429
2296
2143
1980
1981
1831
1982
1833
```

This portion of the input file has been eliminated

```
2402
2404
2531
```

```
2532
2526
2395
2393
2394
2525
2527  ! END NODE NUMBER OF BOUNDARY NO. 1 (MAINLAND)
16 0  ! NUMBER OF NODES IN LAND BOUNDARY NO.2 (CUBA) AND BOUNDARY TYPE (MAINLAND)
1986  ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 2 (CUBA)
1987
1989
1990
1991
1992
1844
1836
1837
1838
1839
1845
1993
1994
2146
2147 ! END NODE NUMBER OF BOUNDARY NO. 2 (CUBA)
34 1 ! NO OF NODES ON LAND BOUND. SEGMENT NO.3 AND BOUNDARY TYPE (ISLAND)
394  ! BEGINNING NODE NO. OF LAND BOUNDARY NO.3 (SKINNY ISL. NEAR APALACHICOLA)
393
395
396
397
452
518
589
630
719
830
831
946
1079
1080
1228
1380
1381
1298
1149
1006
882
769
768
669
```

```
668
670
588
517
516
515
514
450
451  ! END NODE NUMBER OF BOUNDARY NO. 3 (SKINNY ISLAND NEAR APALACHICOLA)
11 1 ! NO OF NODES ON LAND BOUND. SEG. NO.4 AND BOUNDARY TYPE (ISLAND)
227  ! BEGINNING NODE NO. OF LAND BOUND. NO.4 (SMALL FAT ISL. NEAR APALACHICOLA)
221
222
186
223
262
314
370
375
318
266  ! END NODE NUMBER OF BOUNDARY NO. 4 (SMALL FAT ISLAND NEAR APALACHICOLA)
14 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.5 AND BOUNDARY TYPE (ISLAND)
1734 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 5 (CHANDELEUR ISLAND)
1885
2041
2195
2339
2473
2340
2196
2043
2042
1886
1737
1736
1735 ! END NODE NUMBER OF BOUNDARY NO. 5 (CHANDELEUR ISLAND)
25 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.6 AND BOUNDARY TYPE (ISLAND)
2718 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 6 (HALFMOON ISLAND)
2856
2857
3004
3161
3159
3158
3315
3316
3165
3320
3446
3554
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3651
3730
3652
3555
3447
3324
3323
3322
3321
3166
3005
2858 ! END NODE NUMBER OF BOUNDARY NO. 6 (HALFMOON ISLAND)
9 1 ! NO OF NODES ON LAND BOUND SEG. NO.7 AND BOUNDARY TYPE (ISLAND)
310 ! BEGINNING NODE NO. OF LAND BOUND NO.7 (SMALL ISL. AT ENTR. TO PANAMA CITY)
361
362
363
364
421
484
424
367 ! END NODE NUMBER OF BOUNDARY NO. 7 (SMALL ISLAND AT ENTR. TO PANAMA CITY)
15 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.8 AND BOUNDARY TYPE (ISLAND)
2217 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 8 (PETIT BOIS ISLAND)
2216
2220
2218
2219
2356
2358
2490
2616
2743
2886
2748
2619
2491
2363 ! END NODE NUMBER OF BOUNDARY NO. 8 (PETIT BOIS ISLAND)
7 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.9 AND BOUNDARY TYPE (ISLAND)
3174 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 9 (CAT ISLAND)
3173
3329
3454
3331
3330
3175 ! END NODE NUMBER OF BOUNDARY NO. 9 (CAT ISLAND)
15 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.10 AND BOUNDARY TYPE (ISLAND)
2208  ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 10 (HORN ISLAND)
2209
2351
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2352
2484
2606
2732
2871
3020
3038
2885
2741
2613
2486
2354 ! END NODE NUMBER OF BOUNDARY NO. 10 (HORN ISLAND)
25 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.11 AND BOUNDARY TYPE (ISLAND)
2223 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 11 (DAUPHIN ISLAND)
2225
2224
2365
2496
2625
2753
2894
3044
3198
3202
3053
2901
2757
2628
2497
2367
2230
2231
2232
2236
2235
2234
2233
2364 ! END NODE NUMBER OF BOUNDARY NO. 11 (DAUPHIN ISLAND)
8 1 ! NO. OF NODES ON LAND BOUND. SEG. NO.12 AND BOUNDARY TYPE (ISLAND)
2730 ! BEGINNING NODE NUMBER OF LAND BOUNDARY NO. 12 (SHIP ISLAND)
2869
2870
3018
3026
2875
2735
2731  ! END NODE NUMBER OF BOUNDARY NO. 12 (SHIP ISLAND)
62 1 ! NO OF NODES ON LAND  SEG. NO.13 AND BOUNDARY TYPE (ISLAND)
1503 ! BEGINNING NODE NO. OF LAND BOUN NO.13 (ISL BETWEEN PENSACOLA AND DESTIN)
1505
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1629
1630
1776
1929
2084
2242
2377
2507
2638
2771
2919
3073
3224
3357
3475
3579
3675
3590
3486
3368
3232
3081
2926
2780
2645
2514
2382
2248
2092
1934
1789
1647
1508
1370
1218
1217
1061
1062
1063
1064
1065
1066
1216
1215
1214
1213
1212
1211
1369
1368
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1367
1366
1365
1364
1363
1362
1361
1360
1506
1504 ! END NODE NUMBER OF BOUNDARY NO. 13 (ISLAND BETWEEN PENSACOLA AND DESTIN)
```

Sample Input File for Example 2 to UNIT 15

```
gomex_g11_v019_s                 ! 32 CHARACTER ALPHANUMERIC RUN DESCRIPTION
RUN GG4 - v24.16                 ! 24 CHARACTER ALPHANUMERIC RUN IDENTIFICATION
1  ! NFOVER - NONFATAL ERROR OVERRIDE OPTION
0  ! NABOUT - ABREVIATED OUTPUT OPTION PARAMETER
1  ! NSCREEN - UNIT 6 OUTPUT OPTION PARAMETER
0  ! IHOT - HOT START PARAMETER
2  ! ICS - COORDINATE SYSTEM SELECTION PARAMETER
0  ! IM - MODEL TYPE (0 INDICATES STANDARD 2DDI MODEL)
1  ! NOLIBF - BOTTOM FRICTION TERM SELECTION PARAMETER
1  ! NOLIFA - FINITE AMPLITUDE TERM SELECTION PARAMETER
1  ! NOLICA - SPATIAL DERIVATIVE CONVECTIVE TERM SELECTION PARAMETER
1  ! NOLICAT -TIME DERIVATIVE CONVECTIVE TERM SELECTION PARAMETER
0  ! NWP - VARIABLE BOTTOM FRICTION AND LATERAL VISCOSITY OPTION PARAMETER
1  ! NCOR - VARIABLE CORIOLIS IN SPACE OPTION PARAMETER
1  ! NTIP - TIDAL POTENTIAL OPTION PARAMETER
0  ! NWS - WIND STRESS AND BAROMETRIC PRESSURE OPTION PARAMETER
1  ! NRAMP - RAMP FUNCTION OPTION
9.81        ! G - ACCELERATION DUE TO GRAVITY - DETERMINES UNITS
0.0004      ! TAU0 - WEIGHTING FACTOR IN GWCE
90.0        ! DT - TIME STEP (IN SECONDS)
0.0         ! STATIM - STARTING TIME (IN DAYS)
0.0         ! REFTIM - REFERENCE TIME (IN DAYS)
44.0        ! RNDAY - TOTAL LENGTH OF SIMULATION (IN DAYS)
2.0         ! DRAMP - DURATION OF RAMP FUNCTION (IN DAYS)
0.35 0.30 0.35  ! TIME WEIGHTING FACTORS FOR THE GWCE EQUATION
3.0         ! H0 - MINIMUM CUTOFF DEPTH
265.5 29.0 ! SLAM0,SFEA0 - CENTER OF CPP PROJECTION (NOT USED IF ICS=1, NTIP=0,
             NCOR=0)
0.003       ! FFACTOR - HOMOGENEOUS LINEAR OR NONLINEAR BOTTOM FRICTION COEFFICIENT
0.0         ! ESL - LATERAL EDDY VISCOSITY COEFFICIENT; IGNORED IF NWP = 1
0.0         ! CORI - CORIOLIS PARAMETER - IGNORED IF NCOR = 1
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5          ! NTIF - NUMBER OF TIDAL POTENTIAL CONSTITUENTS BEING FORCED
K1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 1
0.141565 0.000072921165921 0.690 1.0 0.0 ! TID POT AMP,FREQ,ETRF,NOD FAC,EQUIL ARG
                                           FOR CONSTIT 1
O1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 2
0.100514 0.000067597751162 0.690 1.0 0.0 ! TID POT AMP,FREQ,ETRF,NOD FAC,EQUIL ARG
                                           FOR CONSTIT 2
P1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 3
0.046834 0.000072522946000 0.690 1.0 0.0 ! TID POT AMP,FREQ,ETRF,NOD FAC,EQUIL ARG
                                           FOR CONSTIT 3
M2         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 4
0.242339 0.000140518917083 0.690 1.0 0.0 ! TID POT AMP,FREQ,ETRF,NOD FAC,EQUIL ARG
                                           FOR CONSTIT 4
S2         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 5
0.113033 0.000145444119418 0.690 1.0 0.0 ! TID POT AMP,FREQ,ETRF,NOD FAC,EQUIL ARG
                                           FOR CONSTIT 5
5          ! NBFR - TOTAL NUMBER OF FORCING FREQUENCIES ON OPEN BOUNDARIES
K1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 1
0.000072921165921 1.0 0.0 ! CONST. FREQ., NODAL FACTOR, EQUIL. ARG. FOR CONST. NO. 1
O1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 2
0.000067597751162 1.0 0.0 ! CONST. FREQ., NODAL FACTOR, EQUIL. ARG. FOR CONST. NO. 2
P1         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 3
0.000072522946000 1.0 0.0 ! CONST. FREQ., NODAL FACTOR, EQUIL. ARG. FOR CONST. NO. 3
M2         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 4
0.000140518917083 1.0 0.0 ! CONST. FREQ., NODAL FACTOR, EQUIL. ARG. FOR CONST. NO. 4
S2         ! ALPHA DESCRIPTOR FOR CONSTITUENT NO. 5
0.000145444119418 1.0 0.0 ! CONST. FREQ., NODAL FACTOR, EQUIL. ARG. FOR CONST. NO. 5
K1        ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOWS
 0.04 50.0     ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 1 AT FIRST NODE
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.09 8.500
 0.089237 7.008
 0.088536 5.492
 0.087897 3.952
 0.087323 2.391
 0.086815 0.811
 0.086374 359.21
 0.086 357.6
 0.086 357.6
 0.086 357.6
 0.086 357.6
 0.086 357.6  ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 1 AT LAST NODE
O1        ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOWS
 0.04 20.0     ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 2 AT FIRST NODE
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```
 0.04 20.0
 0.04 20.0
 0.04 20.0
 0.04 20.0
 0.04 20.0
 0.04 20.0
 0.04 20.0
 0.101 5.00
 0.0992 4.25
 0.0975 3.46
 0.0957 2.65
 0.0940 1.81
 0.0923 0.94
 0.0906 0.004
 0.089 359.1
 0.089 359.1
 0.089 359.1
 0.089 359.1
 0.089 359.1  ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 2 AT LAST NODE
P1          ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOWS
 0.0075 20.0  ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 3 AT FIRST NODE
 0.0075 20.0
 0.0075 20.0
 0.0075 20.0
 0.0075 20.0
 0.0075 20.0
 0.0075 20.0
 0.0075 20.0
 0.02600 9.700
 0.0263 8.53
 0.0265 7.38
 0.0268 6.26
 0.02708 5.16
 0.02738 4.08
 0.02768 3.03
 0.028 2.0
 0.028 2.0
 0.028 2.0
 0.028 2.0
 0.028 2.0    ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 3 AT LAST NODE
M2          ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOW:
 0.07 35.00   ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 4 AT FIRST NODE
 0.07 35.00
 0.07 35.00
 0.07 35.00
 0.07 35.00
 0.07 35.00
 0.07 35.00
 0.07 35.00
 0.13 45.9
```

```
 0.1344 50.155
 0.1395 54.12
 0.1452 57.79
 0.1515 61.166
 0.1583 64.26
 0.1654 67.10
 0.173 69.7
 0.173 69.7
 0.173 69.7
 0.173 69.7
 0.173 69.7    ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 4 AT LAST NODE
S2        ! ALPHA NUMERIC DESCRIPTION OF OPEN BOUNDARY FORCING DATA SET WHICH FOLLOWS
 0.04 50.0     ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 5 AT FIRST NODE
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 50.0
 0.04 69.5
 0.04137 73.62
 0.04290 77.46
 0.04465 81.01
 0.04654 84.29
 0.04857 87.30
 0.05073 90.07
 0.053 92.6
 0.053 92.6
 0.053 92.6
 0.053 92.6
 0.053 92.6    ! BOUNDARY FORCING DATA FOR CONSTITUENT NO. 5 AT LAST NODE
45.0 : ANGINN - INNER ANGLE THRESHOLD
1 30.0 44.0  5 ! NOUTE,TOUTSE,TOUTFE,NSPOOLE:ELEV STATION OUTPUT INFO (UNIT  61)
 20  ! TOTAL NUMBER OF ELEVATION RECORDING STATIONS
 -0.81800003E+02   0.24716000E+02   ! COORD. OF RECORDING ELEVATION STATIONS
 -0.81800003E+02   0.26129997E+02
 -0.83031602E+02   0.29130004E+02
 -0.84182998E+02   0.30065997E+02
 -0.85750000E+02   0.30132773E+02
 -0.88849998E+02   0.30398026E+02
 -0.89166000E+02   0.30233002E+02
 -0.89319555E+02   0.30270683E+02
 -0.89428001E+02   0.28929999E+02
 -0.91449997E+02   0.29286004E+02
 -0.94790001E+02   0.29300007E+02
 -0.97057999E+02   0.27825004E+02
 -0.97150001E+02   0.26066002E+02
 -0.97711313E+02   0.22216007E+02
 -0.94412003E+02   0.18233697E+02
```

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 -0.90642026E+02   0.19850312E+02
 -0.89650002E+02   0.21317480E+02
 -0.82366600E+02   0.23165764E+02
 -0.89650002E+02   0.24760004E+02
 -0.84249999E+02   0.26700001E+02
1 38.0 44.0  5 ! NOUTV,TOUTSV,TOUTFV,NSPOOLV:VEL. STATION OUTPUT INFO (UNIT  62)
 20  ! TOTAL NUMBER OF VELOCITY RECORDING STATIONS
 -0.89461601E+02   0.30079601E+02            ! COORD. OF VELOCITY STATIONS
 -0.89443001E+02   0.30112809E+02
 -0.89450302E+02   0.30162298E+02
 -0.89161201E+02   0.30196504E+02
 -0.89110298E+02   0.30322006E+02
 -0.89137299E+02   0.30261002E+02
 -0.89029800E+02   0.30290509E+02
 -0.88986603E+02   0.30199207E+02
 -0.88829597E+02   0.30244999E+02
 -0.88778999E+02   0.30243001E+02
 -0.88776001E+02   0.30311009E+02
 -0.88680298E+02   0.30269005E+02
 -0.88510597E+02   0.30266007E+02
 -0.88512497E+02   0.30207507E+02
 -0.88451301E+02   0.30247100E+02
 -0.88373001E+02   0.30219603E+02
 -0.88328598E+02   0.30228800E+02
 -0.88300797E+02   0.30291509E+02
 -0.88121597E+02   0.30294007E+02
 -0.88028999E+02   0.30229506E+02
1 40.0 41.0 10 ! NOUTGE,TOUTSGE,TOUTFGE,NSPOOLGE:GLOBAL ELEV OUTPUT INFO (UNIT  63)
1 40.0 41.0 10 ! NOUTGV,TOUTSGV,TOUTFGV,NSPOOLGV:GLOBAL VEL  OUTPUT INFO (UNIT  64)
22 ! NHARFR - NUMBER OF CONSTITUENTS TO BE INCLUDED IN THE HARMONIC ANALYSIS
 STEADY  ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=1
 0.00000000000000 1.0 0.0  ! HAFREQ(I=1),HAFF(I=1),HAFACE(I=1)
 SM      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=2
 0.000004925202335 1.0 0.0 ! HAFREQ(I=2),HAFF(I=2),HAFACE(I=2)
 K1      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=3
 0.000072921165921 1.0 0.0 ! HAFREQ(I=3),HAFF(I=3),HAFACE(I=3)
 O1      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=4
 0.000067597751162 1.0 0.0 ! HAFREQ(I=4),HAFF(I=4),HAFACE(I=4)
 P1      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=5
 0.000072522946000 1.0 0.0 ! HAFREQ(I=5),HAFF(I=5),HAFACE(I=5)
 SO1     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=6
 0.000077846368256 1.0 0.0 ! HAFREQ(I=6),HAFF(I=6),HAFACE(I=6)
 2MS2    ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=7
 0.000135593714748 1.0 0.0 ! HAFREQ(I=7),HAFF(I=7),HAFACE(I=7)
 M2      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=8
 0.000140518917083 1.0 0.0 ! HAFREQ(I=8),HAFF(I=8),HAFACE(I=8)
 S2      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=9
 0.000145444119418 1.0 0.0 ! HAFREQ(I=9),HAFF(I=9),HAFACE(I=9)
 K2      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=10
 0.000145842331800 1.0 0.0 ! HAFREQ(I=10),HAFF(I=10),HAFACE(I=10)
```

```
2SM2     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=11
0.000150369321753 1.0 0.0 ! HAFREQ(I=11),HAFF(I=11),HAFACE(I=11)
MO3      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=12
0.000208116668245 1.0 0.0 ! HAFREQ(I=12),HAFF(I=12),HAFACE(I=12)
SO3/MK3 ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=13
0.000213041870580 1.0 0.0 ! HAFREQ(I=13),HAFF(I=13),HAFACE(I=13)
SK3      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=14
0.000218365285339 1.0 0.0 ! HAFREQ(I=14),HAFF(I=14),HAFACE(I=14)
3MS4     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=15
0.000276112631831 1.0 0.0 ! HAFREQ(I=15),HAFF(I=15),HAFACE(I=15)
M4       ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=16
0.000281037834166 1.0 0.0 ! HAFREQ(I=16),HAFF(I=16),HAFACE(I=16)
MS4      ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=17
0.000285963036501 1.0 0.0 ! HAFREQ(I=17),HAFF(I=17),HAFACE(I=17)
M6       ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=18
0.000421556751249 1.0 0.0 ! HAFREQ(I=18),HAFF(I=18),HAFACE(I=18)
2MS6     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=19
0.000426481953584 1.0 0.0 ! HAFREQ(I=19),HAFF(I=19),HAFACE(I=19)
2SM6     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=20
0.000431407155919 1.0 0.0 ! HAFREQ(I=20),HAFF(I=20),HAFACE(I=20)
M8       ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=21
0.000562075668332 1.0 0.0 ! HAFREQ(I=21),HAFF(I=21),HAFACE(I=21)
3MS8     ! HAFNAM(I) - ALHPANUMERIC DESCRIPTION OF HARMONIC CONSTITUENT I=22
0.000567000870667 1.0 0.0 ! HAFREQ(I=22),HAFF(I=22),HAFACE(I=22)
14.00  44.00  20  0.25 ! THAS,THAF,NHAINC,FMV - HARMONIC ANALYSIS PARAMETERS
1 1 1 1 ! NHASE,NHASV,NHAGE,NHAGV - CONTROL HARMONIC ANALYSIS AND OUTPUT TO UNITS
                                                        51,52,53,54
1 200    ! NHSTAR,NHSINC - HOT START FILE GENERATION PARAMETERS
1  0  1.E-5  25 ! ITITER, ISLDIA, CONVCR, ITMAX - ALGEBRAIC SOLUTION PARAMETERS
```

Sample Output File for Example 2 to UNIT 6

```
THE INPUT PROCESS HAS NOW BEEN COMPLETED WITH THE EXCEPTION OF UNIT 22 INPUT
    WHICH WILL BE READ IN AT EACH TIME STEP
```

```
NON TIME DEPENDENT COEFF AND MARTIX ASSEMBLY SECTION, INCL MATRIX CONDITIONING


THE NEIGHBOR TABLE IS BEING COMPUTED

THE NEIGHBOR TABLE IS COMPLETED
    THE MINIMUM NUMBER OF NEIGHBORS FOR ANY NODE =    3
```

```
    1+THE MAXIMUM NUMBER OF NEIGHBORS FOR ANY NODE =  10
    IN FUTURE RUNS THE PARAMETER MNEI CAN BE SET =  10


BASIC ELEMENT MATRIX SET UP - STARTING
BASIC ELEMENT MATRIX SET UP - COMPLETED


GWCE SYSTEM MATRIX SET UP - STARTS
GWCE SYSTEM MATRIX SET UP - COMPLETED


GWCE SYSTEM MATRIX ; BC INCLUSION - STARTS
GWCE SYSTEM MATRIX ; BC INCLUSION - COMPLETED
```

```
LIMITED RUNTIME INFORMATION SECTION


TIME STEP =       1          NUMBER OF ITERATIONS =    9
   ELMAX =  0.335E-03 AT NODE   2147    SPEEDMAX =  0.936E-05 AT NODE   2292
TIME STEP =       2          NUMBER OF ITERATIONS =    9
   ELMAX =  0.674E-03 AT NODE   2147    SPEEDMAX =  0.376E-04 AT NODE   2292
TIME STEP =       3          NUMBER OF ITERATIONS =    9
   ELMAX =  0.102E-02 AT NODE   2147    SPEEDMAX =  0.848E-04 AT NODE   2292
TIME STEP =       4          NUMBER OF ITERATIONS =    8
   ELMAX =  0.136E-02 AT NODE   2147    SPEEDMAX =  0.151E-03 AT NODE   2292
TIME STEP =       5          NUMBER OF ITERATIONS =    8
   ELMAX =  0.171E-02 AT NODE   2147    SPEEDMAX =  0.237E-03 AT NODE   2292
TIME STEP =       6          NUMBER OF ITERATIONS =    8
   ELMAX =  0.206E-02 AT NODE   2147    SPEEDMAX =  0.341E-03 AT NODE   2292
TIME STEP =       7          NUMBER OF ITERATIONS =    8
   ELMAX =  0.242E-02 AT NODE   2147    SPEEDMAX =  0.465E-03 AT NODE   2292
TIME STEP =       8          NUMBER OF ITERATIONS =    8
   ELMAX =  0.278E-02 AT NODE   2147    SPEEDMAX =  0.607E-03 AT NODE   2292
TIME STEP =       9          NUMBER OF ITERATIONS =    8
   ELMAX =  0.314E-02 AT NODE   2147    SPEEDMAX =  0.767E-03 AT NODE   2292
TIME STEP =      10          NUMBER OF ITERATIONS =    9
   ELMAX =  0.351E-02 AT NODE   2147    SPEEDMAX =  0.945E-03 AT NODE   2292
```

A portion of the output has been eliminated here

```
 TIME STEP =  42231          NUMBER OF ITERATIONS =    5
   ELMAX = -0.350E+00 AT NODE   1399    SPEEDMAX =  0.779E+00 AT NODE   1929
TIME STEP =  42232          NUMBER OF ITERATIONS =    5
   ELMAX = -0.351E+00 AT NODE   1399    SPEEDMAX =  0.780E+00 AT NODE   1929
TIME STEP =  42233          NUMBER OF ITERATIONS =    5
   ELMAX = -0.353E+00 AT NODE   1399    SPEEDMAX =  0.781E+00 AT NODE   1929
```

```
TIME STEP =    42234          NUMBER OF ITERATIONS =    5
   ELMAX = -0.355E+00 AT NODE   1535   SPEEDMAX =  0.782E+00 AT NODE   1929
TIME STEP =    42235          NUMBER OF ITERATIONS =    5
   ELMAX = -0.357E+00 AT NODE   1535   SPEEDMAX =  0.783E+00 AT NODE   1929
TIME STEP =    42236          NUMBER OF ITERATIONS =    5
   ELMAX = -0.359E+00 AT NODE   1535   SPEEDMAX =  0.783E+00 AT NODE   1929
TIME STEP =    42237          NUMBER OF ITERATIONS =    5
   ELMAX = -0.362E+00 AT NODE   1535   SPEEDMAX =  0.784E+00 AT NODE   1929
TIME STEP =    42238          NUMBER OF ITERATIONS =    5
   ELMAX = -0.364E+00 AT NODE   1535   SPEEDMAX =  0.785E+00 AT NODE   1929
TIME STEP =    42239          NUMBER OF ITERATIONS =    5
   ELMAX = -0.365E+00 AT NODE   1535   SPEEDMAX =  0.786E+00 AT NODE   1929
TIME STEP =    42240          NUMBER OF ITERATIONS =    5
   ELMAX = -0.367E+00 AT NODE   1535   SPEEDMAX =  0.786E+00 AT NODE   1929
```

Sample Output File for Example 2 to UNIT 16

```
                  PROGRAM ADCIRC-V024   VERSION 24.16

    AN ADVANCED CIRCULATION MODEL FOR SHELVES, COASTAL SEAS AND ESTUARIES


       -  DEVELOPED FOR

          THE U.S. ARMY ENGINEERS WATERWAYS EXPERIMENT STATION
            UNDER CONTRACT WITH THE DREDGED RESEARCH PROGRAM


       -  DEVELOPED BY

          J.J. WESTERINK
            DEPARTMENT OF CIVIL ENGINEERING AND GEOLOGICAL SCIENCES
            UNIVERSITY OF NOTRE DAME

          R.A. LUETTICH, JR
            UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
            INSTITUTE OF MARINE SCIENCES
```

```
THE ADCIRC SOURCE CODE HAS BEEN CONFIGURED AS FOLLOWS:

      - 2D DEPTH INTEGRATED MODEL OPTION
      - CODE SETUP TO RUN ON A 64 BIT COMPUTER
      - CODE OPTIMIZED FOR A VECTOR COMPUTER
      - NONVECTORIZABLE PARTS OF CODE OPTIMIZED FOR SPEED
      - CODE CONFIGURED FOR AN ITERATIVE SOLVER
```

```
RUN DESCRIPTION :  gomex_g11_v019_s

RUN IDENTIFICATION :  RUN GG4 - v24.16
```

```
PRELIMINARY RUN INFORMATION


    NFOVER =  1
        NON-FATAL ERRORS WILL BE CORRECTED AND EXECUTION WILL CONTINUE
        IF NON-FATAL ERRORS ARE DETECTED


    NABOUT =   0
        DETAILED OUTPUT WILL BE PROVIDED TO UNIT 16 SUCH  THAT
        UNIT 14, 15, 21 AND 22 INPUT DATA WILL BE ECHO PRINTED

    NSCREEN =  1
        SCREEN OUTPUT WILL BE PROVIDED TO UNIT 6
```

```
GENERAL RUN INFORMATION



    THE MODEL WILL BE COLD STARTED FROM REST


    ICS =  2
        GOVERNING EQUATIONS ARE BASED ON SPHERICAL COORDINATES
```

```
        MAPPED USING A CPP PROJECTION

    NOLIBF =    1
        BOTTOM FRICTION TERM SELECTION :  NONLINEAR BOTTOM FRICTION

    NOLIFA =    1
        FINITE AMPLITUDE TERM SELECTION :  TURNED ON

    NOLICA =    1
        SPATIAL DERIVATIVE COMPONENTS OF THE CONVECTIVE
        ACCELERATION TERMS :  TURNED ON

    NOLICAT =    1
        TIME DERIVATIVE COMPONENTS OF THE CONVECTIVE
        ACCELERATION TERMS IN THE GWCE :  TURNED ON

    NWP =  0
        A CONSTANT BOTTOM FRICTION AND EDDY VISCOSITY VALUE WILL BE USED
        THROUGHOUT THE DOMAIN

    NCOR =  1
        SPATIALLY VARYING CORIOLIS VALUES WILL BE COMPUTED
        BASED ON INPUT LATITUDES

    NTIP =  1
        TIDAL POTENTIAL FUNCTION FORCING IS USED IN THIS COMPUTATION AND IS
        BASED ON INPUT LONGITUDES/LATITUDES

    NWS =  0
        NO WIND STRESS OR SURFACE PRESSURE ARE APPLIED IN THIS COMPUTATION

    NRAMP =  1
        A HYPERBOLIC TANGENT RAMP IS APPLIED TO THE FORCING FUNCTIONS


    GRAVITATIONAL CONSTANT G =    9.81000


    WEIGHTING COEFFICIENT FOR THE GENERALIZED WAVE CONTINUITY EQUATION :
    TAU0 = 0.40000000E-03  1/sec


------------------------------------------------------------------------------


TIME INTEGRATION INFORMATION


    TIME STEP =    90.000000      SECONDS
```

```
STARTING TIME FOR SIMULATION =       0.000000 DAYS

REFERENCE TIME FOR SIMULATION =       0.000000 DAYS

TOTAL LENGTH OF NUMERICAL SIMULATION =     44.0000     DAYS

NUMBER OF TIME STEPS  =   42240


VALUE FOR DRAMP USED IN RAMP EVALUATION =      2.0000     DAYS

       DAYS OF SIMULATION   TIME          RAMP

              0.00          0.00        0.0000000
              0.50          0.50        0.4621172
              1.00          1.00        0.7615942
              1.50          1.50        0.9051483
              2.00          2.00        0.9640276
              2.50          2.50        0.9866143
              3.00          3.00        0.9950548
              4.00          4.00        0.9993293
              5.00          5.00        0.9999092
              6.00          6.00        0.9999877
              7.00          7.00        0.9999983
              8.00          8.00        0.9999998
              9.00          9.00        1.0000000
             10.00         10.00        1.0000000
             11.00         11.00        1.0000000
             12.00         12.00        1.0000000
             13.00         13.00        1.0000000
             14.00         14.00        1.0000000
             15.00         15.00        1.0000000
             16.00         16.00        1.0000000
             17.00         17.00        1.0000000
             18.00         18.00        1.0000000
             19.00         19.00        1.0000000
             20.00         20.00        1.0000000


TIME WEIGHTING FACTORS IN THE WAVE EQUATION :

    AT TIME LEVEL K+1 :  0.35000
    AT TIME LEVEL K   :  0.30000
    AT TIME LEVEL K-1 :  0.35000
```

```
THE INPUT GRID INFORMATION IS AS FOLLOWS :


    GRID IDENTIFICATION : gomex_g11_v018_s.grd

    TOTAL NUMBER OF NODES =  3939

    TOTAL NUMBER OF ELEMENTS =  6807

    MINIMUM BATHYMETRIC VALUE =       3.0000

    LATITUDE ABOUT WHICH CPP PROJECTION IS CENTERED  SLAM0 =  265.5000 DEGREES
    LONGITUDE ABOUT WHICH CPP PROJECTION IS CENTERED  SFEA0 =   29.0000 DEGREES


NODAL COORDINATES AND BATHYMETRY :

   NODE   LAMBDA(DEG)      FEA(DEG)        XCP           YCP         DP

     1   -85.35936100    29.70021900    -34160818.1    3306249.2    3.86
     2   -85.35054300    29.68592000    -34159959.6    3304657.5    6.17
     3   -85.34590700    29.71650100    -34159508.2    3308061.8    7.80
     4   -85.37295200    29.71885200    -34162141.4    3308323.5    7.59
     5   -85.32504400    29.69219200    -34157476.9    3305355.7    3.29
     6   -85.32736200    29.71963700    -34157702.6    3308410.9    6.99
     7   -85.35730300    29.74650800    -34160617.8    3311402.2    9.38
     8   -85.33313100    29.74564000    -34158264.3    3311305.5    8.47
     9   -85.38686100    29.74081400    -34163495.6    3310768.3    9.18
    10   -85.30418000    29.70473700    -34155445.5    3306752.2    3.29
```

This portion of the output file has been eliminated

```
  3930   -90.26492500    30.24022500    -34638439.9    3366363.1    3.00
  3931   -90.26215400    30.35509800    -34638170.2    3379150.8    3.00
  3932   -90.17864100    30.39053000    -34630039.1    3383095.1    3.00
  3933   -90.26793700    30.05911800    -34638733.2    3346202.1    5.19
  3934   -90.34690500    30.06009900    -34646421.8    3346311.3    3.00
  3935   -90.35362600    30.17024600    -34647076.2    3358573.0    3.00
  3936   -90.37130300    30.23154200    -34648797.3    3365396.5    3.00
  3937   -90.31204800    30.30184800    -34643028.0    3373223.0    3.00
  3938   -90.41460800    30.10591000    -34653013.6    3351411.0    3.00
  3939   -90.43103700    30.18846700    -34654613.2    3360601.3    3.00


    GLOBAL NODE NUMBERS FOR EACH ELEMENT :

        ELEMENT        N1        N2        N3

             1       3790      3757      3758
             2       3790      3758      3759
```

3	3757	3756	3700
4	3757	3700	3758
5	3758	3701	3759
6	3756	3698	3699
7	3758	3700	3701
8	3756	3699	3700
9	3698	3695	3609
10	3698	3609	3699

This portion of the output file has been eliminated

6798	3666	3742	3668
6799	3574	3573	3669
6800	3573	3668	3669
6801	3742	3743	3668
6802	3667	3574	3670
6803	3574	3669	3670
6804	3668	3744	3669
6805	3668	3743	3744
6806	3669	3745	3670
6807	3669	3744	3745

BOTTOM FRICTION AND LATERAL VISCOSITY INFORMATION

NONLINEAR FRICTION COEFFICIENT CF = 0.00300000

ESL, CONSTANT EDDY VISCOSITY = 0.00000000E+00

CORIOLIS INFORMATION

LATITUDES ARE USED TO COMPUTE VARIABLE CORIOLIS
AND ARE BASED ON INPUT NODAL COORDINATES

NODE	NODAL CORIOLIS CORIF
1	0.722593655E-04
2	0.722277477E-04
3	0.722953627E-04

4	0.723005599E-04
5	0.722416168E-04
6	0.723022953E-04
7	0.723616886E-04
8	0.723597703E-04
9	0.723491044E-04
10	0.722693548E-04

This portion of the output file has been eliminated

3930	0.734501112E-04
3931	0.737025751E-04
3932	0.737803865E-04
3933	0.730514813E-04
3934	0.730536425E-04
3935	0.732961690E-04
3936	0.734310160E-04
3937	0.735855809E-04
3938	0.731545440E-04
3939	0.733362627E-04

TIDAL POTENTIAL FORCING INFORMATION

TIDAL POTENTIAL IS FORCED FOR 5 CONSTITUENT(S)

AMPLITUDE	FREQUENCY	ETRF	NODAL FACTOR	EQU.ARG(DEG)	CONSTITUENT
0.1415650	0.000072921166	0.6900000	1.0000000	0.000	K1
0.1005140	0.000067597751	0.6900000	1.0000000	0.000	O1
0.0468340	0.000072522946	0.6900000	1.0000000	0.000	P1
0.2423390	0.000140518917	0.6900000	1.0000000	0.000	M2
0.1130330	0.000145444119	0.6900000	1.0000000	0.000	S2

LONGITUDES AND LATITUDES ARE USED TO COMPUTE THE TIDAL POTENTIAL FUNCTION
AND ARE BASED ON INPUT NODAL COORDINATES

OPEN OCEAN BOUNDARY FORCING INFORMATION

```
NUMBER OF BOUNDARY TIDAL FORCING CONSTITUENTS =    5

  CONSTITUENT #     FREQUENCY     NODAL FACTOR   EQU.ARG (DEG)   CONSTITUENT

        1        0.000072921166    1.0000000       0.000           K1
        2        0.000067597751    1.0000000       0.000           O1
        3        0.000072522946    1.0000000       0.000           P1
        4        0.000140518917    1.0000000       0.000           M2
        5        0.000145444119    1.0000000       0.000           S2


TOTAL NUMBER OF OPEN BOUNDARY FORCING SEGMENTS =     2

TOTAL NUMBER OF OPEN BOUNDARY FORCING NODES =    20


TOTAL NUMBER OF NODES ON OPEN BOUNDARY SEGMENT   1  =     8

     2527
     2398
     2270
     2145
     2144
     1988
     1985
     1986


TOTAL NUMBER OF NODES ON OPEN BOUNDARY SEGMENT   2  =    12

     2147
     2148
     2149
     2150
     2151
     2152
     2153
     2154
     2155
     2291
     2292
     2427



OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER    1 DESIGNATED :  K1
    VERIFICATION OF CONSTITUENT :  K1
```

NODE	AMPL.	PHASE(DEG)
2527	0.04000	50.000
2398	0.04000	50.000
2270	0.04000	50.000
2145	0.04000	50.000
2144	0.04000	50.000
1988	0.04000	50.000
1985	0.04000	50.000
1986	0.04000	50.000
2147	0.09000	8.500
2148	0.08924	7.008
2149	0.08854	5.492
2150	0.08790	3.952
2151	0.08732	2.391
2152	0.08682	0.811
2153	0.08637	359.210
2154	0.08600	357.600
2155	0.08600	357.600
2291	0.08600	357.600
2292	0.08600	357.600
2427	0.08600	357.600

OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER 2 DESIGNATED : O1
VERIFICATION OF CONSTITUENT : O1

NODE	AMPL.	PHASE(DEG)
2527	0.04000	20.000
2398	0.04000	20.000
2270	0.04000	20.000
2145	0.04000	20.000
2144	0.04000	20.000
1988	0.04000	20.000
1985	0.04000	20.000
1986	0.04000	20.000
2147	0.10100	5.000
2148	0.09920	4.250
2149	0.09750	3.460
2150	0.09570	2.650
2151	0.09400	1.810
2152	0.09230	0.940
2153	0.09060	0.004
2154	0.08900	359.100
2155	0.08900	359.100
2291	0.08900	359.100
2292	0.08900	359.100

2427	0.08900	359.100

OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER 3 DESIGNATED : P1
VERIFICATION OF CONSTITUENT : P1

NODE	AMPL.	PHASE(DEG)
2527	0.00750	20.000
2398	0.00750	20.000
2270	0.00750	20.000
2145	0.00750	20.000
2144	0.00750	20.000
1988	0.00750	20.000
1985	0.00750	20.000
1986	0.00750	20.000
2147	0.02600	9.700
2148	0.02630	8.530
2149	0.02650	7.380
2150	0.02680	6.260
2151	0.02708	5.160
2152	0.02738	4.080
2153	0.02768	3.030
2154	0.02800	2.000
2155	0.02800	2.000
2291	0.02800	2.000
2292	0.02800	2.000
2427	0.02800	2.000

OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER 4 DESIGNATED : M2
VERIFICATION OF CONSTITUENT : M2

NODE	AMPL.	PHASE(DEG)
2527	0.07000	35.000
2398	0.07000	35.000
2270	0.07000	35.000
2145	0.07000	35.000
2144	0.07000	35.000
1988	0.07000	35.000
1985	0.07000	35.000
1986	0.07000	35.000
2147	0.13000	45.900
2148	0.13440	50.155
2149	0.13950	54.120

2150	0.14520	57.790
2151	0.15150	61.166
2152	0.15830	64.260
2153	0.16540	67.100
2154	0.17300	69.700
2155	0.17300	69.700
2291	0.17300	69.700
2292	0.17300	69.700
2427	0.17300	69.700

OPEN BOUNDARY TIDAL FORCING FOR CONSTITUENT NUMBER 5 DESIGNATED : S2
VERIFICATION OF CONSTITUENT : S2

NODE	AMPL.	PHASE (DEG)
2527	0.04000	50.000
2398	0.04000	50.000
2270	0.04000	50.000
2145	0.04000	50.000
2144	0.04000	50.000
1988	0.04000	50.000
1985	0.04000	50.000
1986	0.04000	50.000
2147	0.04000	69.500
2148	0.04137	73.620
2149	0.04290	77.460
2150	0.04465	81.010
2151	0.04654	84.290
2152	0.04857	87.300
2153	0.05073	90.070
2154	0.05300	92.600
2155	0.05300	92.600
2291	0.05300	92.600
2292	0.05300	92.600
2427	0.05300	92.600

LAND BOUNDARY INFORMATION

THE TOTAL NUMBER OF LAND BOUNDARY SEGMENTS = 13

THE TOTAL NUMBER OF LAND BOUNDARY NODES = 1075

```
ANGINN =     45.00 DEGREES
ALL LAND BOUNDARY NODES WITH INNER ANGLES LESS THAN ANGINN WILL HAVE
    BOTH NORMAL AND TANGENTIAL COMPONENTS ZEROED



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   1  =     834
THIS SEGMENT IS A MAINLAND BOUNDARY WITH SLIP

2427  THE INNER ANGLE, COS & SIN= ********   0.94496490E+00   0.21826848E+00
2428  THE INNER ANGLE, COS & SIN=   183.54   0.95214186E+00   0.18771665E+00
2429  THE INNER ANGLE, COS & SIN=   141.66   0.86148094E+00   0.46057045E+00
2296  THE INNER ANGLE, COS & SIN=   178.19   0.65092580E+00   0.74222620E+00
2143  THE INNER ANGLE, COS & SIN=   186.90   0.68566201E+00   0.70894403E+00
1980  THE INNER ANGLE, COS & SIN=   185.41   0.75672566E+00   0.62890850E+00
1981  THE INNER ANGLE, COS & SIN=   184.13   0.80396346E+00   0.56534946E+00
1831  THE INNER ANGLE, COS & SIN=   185.16   0.84563083E+00   0.49947572E+00
1982  THE INNER ANGLE, COS & SIN=   166.60   0.82100469E+00   0.54268958E+00
1833  THE INNER ANGLE, COS & SIN=   188.01   0.78363943E+00   0.59865087E+00
```

This portion of the output file has been eliminated

```
2402  THE INNER ANGLE, COS & SIN=   190.30  -0.19578106E+00  -0.97809322E+00
2404  THE INNER ANGLE, COS & SIN=   174.29  -0.24075441E+00  -0.96666728E+00
2531  THE INNER ANGLE, COS & SIN=   183.90  -0.23022245E+00  -0.96955677E+00
2532  THE INNER ANGLE, COS & SIN=   134.50   0.18864493E+00  -0.97965455E+00
2526  THE INNER ANGLE, COS & SIN=   180.53   0.49582290E+00  -0.84975959E+00
2395  THE INNER ANGLE, COS & SIN=   239.04   0.76865957E-01  -0.99665826E+00
2393  THE INNER ANGLE, COS & SIN=   194.09  -0.57789963E+00  -0.78902441E+00
2394  THE INNER ANGLE, COS & SIN=   189.13  -0.72436020E+00  -0.63744382E+00
2525  THE INNER ANGLE, COS & SIN=   202.45  -0.85672803E+00  -0.40973369E+00
2527  THE INNER ANGLE, COS & SIN= ********  -0.90821300E+00  -0.24934080E+00


TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   2  =      16
THIS SEGMENT IS A MAINLAND BOUNDARY WITH SLIP

1986  THE INNER ANGLE, COS & SIN= ********   0.94160101E+00  -0.33544461E-01
1987  THE INNER ANGLE, COS & SIN=   250.21   0.74717647E+00  -0.61001105E+00
1989  THE INNER ANGLE, COS & SIN=   191.51   0.21262664E+00  -0.97425970E+00
1990  THE INNER ANGLE, COS & SIN=   164.42   0.24931034E+00  -0.96444151E+00
1991  THE INNER ANGLE, COS & SIN=   181.65   0.35579776E+00  -0.92619303E+00
1992  THE INNER ANGLE, COS & SIN=    94.57   0.86118651E+00  -0.40946022E+00
1844  THE INNER ANGLE, COS & SIN=   217.94   0.94182590E+00  -0.80123873E-01
1836  THE INNER ANGLE, COS & SIN=   203.59   0.77142990E+00  -0.57868503E+00
1837  THE INNER ANGLE, COS & SIN=   189.83   0.61872422E+00  -0.75714883E+00
1838  THE INNER ANGLE, COS & SIN=   186.78   0.50495779E+00  -0.84639124E+00
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1839  THE INNER ANGLE, COS & SIN=    188.48    0.38545379E+00  -0.91380980E+00
1845  THE INNER ANGLE, COS & SIN=    188.19    0.25685008E+00  -0.96274491E+00
1993  THE INNER ANGLE, COS & SIN=    175.53    0.21831966E+00  -0.97325398E+00
1994  THE INNER ANGLE, COS & SIN=    183.71    0.23487927E+00  -0.96900332E+00
2146  THE INNER ANGLE, COS & SIN=    175.17    0.23822532E+00  -0.96811915E+00
2147  THE INNER ANGLE, COS & SIN= ********    0.28320430E+00  -0.95466491E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   3  =     34
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

 394  THE INNER ANGLE, COS & SIN=    197.34   -0.19451742E+00   0.98112312E+00
 393  THE INNER ANGLE, COS & SIN=    221.57    0.26081057E+00   0.96579828E+00
 395  THE INNER ANGLE, COS & SIN=    176.08    0.60343584E+00   0.80011598E+00
 396  THE INNER ANGLE, COS & SIN=    253.58    0.80108393E+00   0.60499921E+00
 397  THE INNER ANGLE, COS & SIN=    282.27   -0.15578920E+00  -0.98794058E+00
 452  THE INNER ANGLE, COS & SIN=    174.31   -0.46630537E+00  -0.88610120E+00
 518  THE INNER ANGLE, COS & SIN=    141.84   -0.10562561E+00  -0.99447237E+00
 589  THE INNER ANGLE, COS & SIN=    184.09    0.19040806E+00  -0.98192548E+00
 630  THE INNER ANGLE, COS & SIN=    163.24    0.30636380E+00  -0.95250649E+00
 719  THE INNER ANGLE, COS & SIN=    174.78    0.47513024E+00  -0.88148396E+00
```

This portion of the output file has been eliminated

```
 669  THE INNER ANGLE, COS & SIN=    187.68   -0.60936568E+00   0.79611343E+00
 668  THE INNER ANGLE, COS & SIN=    183.80   -0.52861381E+00   0.85108546E+00
 670  THE INNER ANGLE, COS & SIN=    184.03   -0.46717765E+00   0.88580328E+00
 588  THE INNER ANGLE, COS & SIN=    183.62   -0.40790284E+00   0.91421755E+00
 517  THE INNER ANGLE, COS & SIN=    184.20   -0.34245434E+00   0.94034049E+00
 516  THE INNER ANGLE, COS & SIN=    165.49   -0.42853617E+00   0.90482102E+00
 515  THE INNER ANGLE, COS & SIN=    184.14   -0.50607806E+00   0.86434028E+00
 514  THE INNER ANGLE, COS & SIN=    178.22   -0.48815796E+00   0.87442259E+00
 450  THE INNER ANGLE, COS & SIN=    190.23   -0.41688458E+00   0.91010528E+00
 451  THE INNER ANGLE, COS & SIN=    179.89   -0.34184471E+00   0.94049036E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   4  =     11
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

 227  THE INNER ANGLE, COS & SIN=    207.37   -0.13667119E+00   0.99072982E+00
 221  THE INNER ANGLE, COS & SIN=    225.79    0.50082168E+00   0.86729480E+00
 222  THE INNER ANGLE, COS & SIN=    181.15    0.77250809E+00   0.64082368E+00
 186  THE INNER ANGLE, COS & SIN=    303.63    0.10056124E+01   0.41422619E-01
 223  THE INNER ANGLE, COS & SIN=    188.61    0.13052864E-01  -0.99991590E+00
 262  THE INNER ANGLE, COS & SIN=    184.16   -0.88578935E-01  -0.99611972E+00
 314  THE INNER ANGLE, COS & SIN=    169.37   -0.30346443E-01  -0.99954534E+00
 370  THE INNER ANGLE, COS & SIN=    214.77   -0.24249408E+00  -0.97054123E+00
 375  THE INNER ANGLE, COS & SIN=    243.25   -0.92268093E+00  -0.39927335E+00
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 318  THE INNER ANGLE, COS & SIN=   248.17   -0.86569066E+00   0.50964596E+00
 266  THE INNER ANGLE, COS & SIN=   173.70   -0.34933925E+00   0.93778673E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   5  =     14
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

1734  THE INNER ANGLE, COS & SIN=   338.88    0.53519515E+00   0.84721674E+00
1885  THE INNER ANGLE, COS & SIN=   196.30    0.96233764E+00  -0.29724737E+00
2041  THE INNER ANGLE, COS & SIN=   167.17    0.95233983E+00  -0.32843298E+00
2195  THE INNER ANGLE, COS & SIN=   163.66    0.10048098E+01  -0.88025288E-01
2339  THE INNER ANGLE, COS & SIN=   171.56    0.99984278E+00   0.13561304E+00
2473  THE INNER ANGLE, COS & SIN=   182.27    0.99133877E+00   0.18944054E+00
2340  THE INNER ANGLE, COS & SIN=   175.94    0.98884924E+00   0.20352333E+00
2196  THE INNER ANGLE, COS & SIN=   347.07    0.35146680E+00  -0.93754661E+00
2043  THE INNER ANGLE, COS & SIN=   183.74   -0.91717949E+00  -0.41879396E+00
2042  THE INNER ANGLE, COS & SIN=   197.70   -0.97816547E+00  -0.24760872E+00
1886  THE INNER ANGLE, COS & SIN=   184.68   -0.10081483E+01  -0.45228303E-01
1737  THE INNER ANGLE, COS & SIN=   193.18   -0.10033397E+01   0.10271590E+00
1736  THE INNER ANGLE, COS & SIN=   187.54   -0.96615726E+00   0.28584976E+00
1735  THE INNER ANGLE, COS & SIN=   190.31   -0.90945370E+00   0.43087474E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT   6  =     25
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

2718  THE INNER ANGLE, COS & SIN=   272.91   -0.64527284E+00   0.76945850E+00
2856  THE INNER ANGLE, COS & SIN=   184.08    0.14861520E+00   0.98912202E+00
2857  THE INNER ANGLE, COS & SIN=   182.91    0.20930394E+00   0.97830738E+00
3004  THE INNER ANGLE, COS & SIN=   188.68    0.29996164E+00   0.95491732E+00
3161  THE INNER ANGLE, COS & SIN=   136.25    0.00000000E+00   0.10000000E+01
3159  THE INNER ANGLE, COS & SIN=   185.28   -0.32580156E+00   0.94658798E+00
3158  THE INNER ANGLE, COS & SIN=   220.29   -0.68552876E-01   0.99769552E+00
3315  THE INNER ANGLE, COS & SIN=   186.14    0.45336288E+00   0.89368207E+00
3316  THE INNER ANGLE, COS & SIN=   182.66    0.52294273E+00   0.85565572E+00
3165  THE INNER ANGLE, COS & SIN=   186.28    0.59276888E+00   0.80985686E+00
3320  THE INNER ANGLE, COS & SIN=   277.20    0.10083662E+01  -0.65329791E-01
3446  THE INNER ANGLE, COS & SIN=   183.37    0.67283335E+00  -0.74615105E+00
3554  THE INNER ANGLE, COS & SIN=   182.87    0.62816612E+00  -0.78338646E+00
3651  THE INNER ANGLE, COS & SIN=   177.12    0.63483007E+00  -0.77815345E+00
3730  THE INNER ANGLE, COS & SIN=   180.31    0.64859594E+00  -0.76703360E+00
3652  THE INNER ANGLE, COS & SIN=   180.81    0.64003262E+00  -0.77411668E+00
3555  THE INNER ANGLE, COS & SIN=   183.45    0.61352177E+00  -0.79493840E+00
3447  THE INNER ANGLE, COS & SIN=   217.75    0.34068532E+00  -0.94156440E+00
3324  THE INNER ANGLE, COS & SIN=   301.63   -0.87578002E+00  -0.50024571E+00
3323  THE INNER ANGLE, COS & SIN=   167.38   -0.89152808E+00   0.47198295E+00
3322  THE INNER ANGLE, COS & SIN=   186.33   -0.91892353E+00   0.41713806E+00
3321  THE INNER ANGLE, COS & SIN=    89.17   -0.97910970E+00  -0.24882867E+00
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3166  THE INNER ANGLE, COS & SIN=   188.23   -0.51804019E+00  -0.85869129E+00
3005  THE INNER ANGLE, COS & SIN=   235.45   -0.86494684E+00  -0.51730677E+00
2858  THE INNER ANGLE, COS & SIN=   183.45   -0.10099350E+01   0.33338686E-01



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT    7  =      9
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

 310  THE INNER ANGLE, COS & SIN=   307.71   -0.55634154E+00   0.83498809E+00
 361  THE INNER ANGLE, COS & SIN=   181.83    0.43376102E+00   0.90329700E+00
 362  THE INNER ANGLE, COS & SIN=   186.20    0.49768053E+00   0.87046839E+00
 363  THE INNER ANGLE, COS & SIN=   184.70    0.57543594E+00   0.82226133E+00
 364  THE INNER ANGLE, COS & SIN=   273.12    0.10087858E+01   0.68282183E-01
 421  THE INNER ANGLE, COS & SIN=   249.42    0.21041353E+00  -0.97811058E+00
 484  THE INNER ANGLE, COS & SIN=   192.10   -0.44178736E+00  -0.89950569E+00
 424  THE INNER ANGLE, COS & SIN=   205.02   -0.69400786E+00  -0.72725526E+00
 367  THE INNER ANGLE, COS & SIN=   199.91   -0.92770916E+00  -0.39765163E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT    8  =     15
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

2217  THE INNER ANGLE, COS & SIN=   271.02   -0.75189714E+00   0.66929697E+00
2216  THE INNER ANGLE, COS & SIN=   180.47   -0.16543446E+00   0.98654677E+00
2220  THE INNER ANGLE, COS & SIN=   191.91   -0.31496358E-01   0.99951551E+00
2218  THE INNER ANGLE, COS & SIN=   192.76    0.13846480E+00   0.99059456E+00
2219  THE INNER ANGLE, COS & SIN=   185.67    0.30582313E+00   0.95324485E+00
2356  THE INNER ANGLE, COS & SIN=   189.61    0.43222940E+00   0.90420972E+00
2358  THE INNER ANGLE, COS & SIN=   249.05    0.80311037E+00   0.60855010E+00
2490  THE INNER ANGLE, COS & SIN=   274.30    0.28464261E+00  -0.95964139E+00
2616  THE INNER ANGLE, COS & SIN=   188.44   -0.31709963E+00  -0.94965371E+00
2743  THE INNER ANGLE, COS & SIN=   168.58   -0.26706969E+00  -0.96455502E+00
2886  THE INNER ANGLE, COS & SIN=   168.97   -0.94369416E-01  -0.99564310E+00
2748  THE INNER ANGLE, COS & SIN=   145.64    0.27017997E+00  -0.96370658E+00
2619  THE INNER ANGLE, COS & SIN=   198.86    0.43088427E+00  -0.90485536E+00
2491  THE INNER ANGLE, COS & SIN=   267.81   -0.31756024E+00  -0.94950815E+00
2363  THE INNER ANGLE, COS & SIN=   186.92   -0.98076465E+00  -0.24683035E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT    9  =      7
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

3174  THE INNER ANGLE, COS & SIN=   192.87   -0.25448380E+00   0.96786950E+00
3173  THE INNER ANGLE, COS & SIN=   333.92    0.10043466E+01   0.12280235E+00
3329  THE INNER ANGLE, COS & SIN=   186.02    0.53213982E+00  -0.85065638E+00
3454  THE INNER ANGLE, COS & SIN=   159.15    0.63382068E+00  -0.77974556E+00
3331  THE INNER ANGLE, COS & SIN=   335.99   -0.15210150E+00  -0.98865305E+00
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3330  THE INNER ANGLE, COS & SIN=   183.99   -0.96046958E+00   0.31593543E+00
3175  THE INNER ANGLE, COS & SIN=   228.06   -0.63224264E+00   0.78090664E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT  10  =     15
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

2208  THE INNER ANGLE, COS & SIN=   190.49    0.21824958E-01   0.99976746E+00
2209  THE INNER ANGLE, COS & SIN=   187.94    0.17336989E+00   0.98521984E+00
2351  THE INNER ANGLE, COS & SIN=   180.93    0.25124293E+00   0.96870432E+00
2352  THE INNER ANGLE, COS & SIN=   181.80    0.27244689E+00   0.96310069E+00
2484  THE INNER ANGLE, COS & SIN=   161.72    0.13270524E+00   0.99137132E+00
2606  THE INNER ANGLE, COS & SIN=   276.63    0.43765222E+00   0.90172619E+00
2732  THE INNER ANGLE, COS & SIN=   268.29    0.39633567E+00  -0.92020495E+00
2871  THE INNER ANGLE, COS & SIN=   193.52   -0.18260816E+00  -0.98360172E+00
3020  THE INNER ANGLE, COS & SIN=   179.32   -0.28561541E+00  -0.95938003E+00
3038  THE INNER ANGLE, COS & SIN=   170.22   -0.20188070E+00  -0.97991262E+00
2885  THE INNER ANGLE, COS & SIN=   173.53   -0.60937462E-01  -0.99818639E+00
2741  THE INNER ANGLE, COS & SIN=   183.92   -0.28809300E-01  -0.99959493E+00
2613  THE INNER ANGLE, COS & SIN=   209.23   -0.24329592E+00  -0.97068608E+00
2486  THE INNER ANGLE, COS & SIN=   231.75   -0.85057518E+00  -0.54208017E+00
2354  THE INNER ANGLE, COS & SIN=   270.71   -0.39989718E+00   0.91863144E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT  11  =     25
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

2223  THE INNER ANGLE, COS & SIN=   188.05   -0.27503311E+00   0.96238286E+00
2225  THE INNER ANGLE, COS & SIN=   184.26   -0.16127979E+00   0.98722544E+00
2224  THE INNER ANGLE, COS & SIN=   261.89    0.23178289E+00   0.97342915E+00
2365  THE INNER ANGLE, COS & SIN=   265.53    0.62729445E+00  -0.78486638E+00
2496  THE INNER ANGLE, COS & SIN=   182.31    0.32902271E+00  -0.94571919E+00
2625  THE INNER ANGLE, COS & SIN=   195.93    0.19532068E+00  -0.98121629E+00
2753  THE INNER ANGLE, COS & SIN=   168.06    0.14149356E+00  -0.99018723E+00
2894  THE INNER ANGLE, COS & SIN=   189.75    0.15357768E+00  -0.98843026E+00
3044  THE INNER ANGLE, COS & SIN=   166.75    0.18036170E+00  -0.98400766E+00
3198  THE INNER ANGLE, COS & SIN=   207.37    0.70523699E-01  -0.99757175E+00
3202  THE INNER ANGLE, COS & SIN=   155.63    0.36139731E-01  -0.99936287E+00
3053  THE INNER ANGLE, COS & SIN=   207.29   -0.18863292E-01  -0.99982648E+00
2901  THE INNER ANGLE, COS & SIN=   142.57    0.84019001E-01  -0.99655152E+00
2757  THE INNER ANGLE, COS & SIN=   217.87    0.12143012E+00  -0.99278422E+00
2628  THE INNER ANGLE, COS & SIN=   203.77   -0.44506048E+00  -0.89823234E+00
2497  THE INNER ANGLE, COS & SIN=   290.53   -0.99355205E+00   0.19252221E+00
2367  THE INNER ANGLE, COS & SIN=   216.30   -0.28082019E+00   0.96075796E+00
2230  THE INNER ANGLE, COS & SIN=   182.27    0.88507348E-01   0.99617114E+00
2231  THE INNER ANGLE, COS & SIN=   172.08    0.33076546E-01   0.99946615E+00
2232  THE INNER ANGLE, COS & SIN=   186.15    0.23798492E-01   0.99972367E+00
2236  THE INNER ANGLE, COS & SIN=   164.98   -0.35589902E-01   0.99938192E+00
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2235  THE INNER ANGLE, COS & SIN=   185.61   -0.13882507E+00   0.99055352E+00
2234  THE INNER ANGLE, COS & SIN=   174.64   -0.13119224E+00   0.99156786E+00
2233  THE INNER ANGLE, COS & SIN=   187.74   -0.10150374E+00   0.99496077E+00
2364  THE INNER ANGLE, COS & SIN=   162.66   -0.21546928E+00   0.97708684E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT  12  =      8
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

2730  THE INNER ANGLE, COS & SIN=   231.54   -0.20993486E+00   0.97825992E+00
2869  THE INNER ANGLE, COS & SIN=   178.32    0.28083741E+00   0.96075279E+00
2870  THE INNER ANGLE, COS & SIN=   330.71    0.99946982E+00   0.15947106E+00
3018  THE INNER ANGLE, COS & SIN=   198.72    0.77761022E-01  -0.99704628E+00
3026  THE INNER ANGLE, COS & SIN=   153.89    0.16144878E+00  -0.98720398E+00
2875  THE INNER ANGLE, COS & SIN=   182.45    0.34379200E+00  -0.94059361E+00
2735  THE INNER ANGLE, COS & SIN=   336.29   -0.91551360E+00  -0.42728429E+00
2731  THE INNER ANGLE, COS & SIN=   188.08   -0.61772963E+00   0.79230399E+00



TOTAL NUMBER OF NODES FOR LAND BOUNDARY SEGMENT  13  =     62
THIS SEGMENT IS AN ISLAND BOUNDARY WITH SLIP

1503  THE INNER ANGLE, COS & SIN=   181.31   -0.10412484E+00   0.99470527E+00
1505  THE INNER ANGLE, COS & SIN=   206.12    0.11212859E+00   0.99385721E+00
1629  THE INNER ANGLE, COS & SIN=   176.12    0.32609538E+00   0.94679459E+00
1630  THE INNER ANGLE, COS & SIN=   207.34    0.51714730E+00   0.85994945E+00
1776  THE INNER ANGLE, COS & SIN=   287.05    0.99083186E+00   0.20962892E+00
1929  THE INNER ANGLE, COS & SIN=   211.46    0.15737575E+00  -0.98786774E+00
2084  THE INNER ANGLE, COS & SIN=   187.93   -0.13006237E+00  -0.99172950E+00
2242  THE INNER ANGLE, COS & SIN=   167.39   -0.89714236E-01  -0.99607326E+00
2377  THE INNER ANGLE, COS & SIN=   189.33   -0.42139790E-01  -0.99913498E+00
2507  THE INNER ANGLE, COS & SIN=   161.01    0.52022690E-01  -0.99868133E+00
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This portion of the output file has been eliminated

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1367  THE INNER ANGLE, COS & SIN=   185.20   -0.21663497E+00   0.97689273E+00
1366  THE INNER ANGLE, COS & SIN=   181.08   -0.16935158E+00   0.98594138E+00
1365  THE INNER ANGLE, COS & SIN=   181.42   -0.14672029E+00   0.98946550E+00
1364  THE INNER ANGLE, COS & SIN=   178.34   -0.14787935E+00   0.98929668E+00
1363  THE INNER ANGLE, COS & SIN=   170.24   -0.23452002E+00   0.97285419E+00
1362  THE INNER ANGLE, COS & SIN=   190.12   -0.23602295E+00   0.97249681E+00
1361  THE INNER ANGLE, COS & SIN=   176.24   -0.18542376E+00   0.98311489E+00
1360  THE INNER ANGLE, COS & SIN=   182.48   -0.20117834E+00   0.98009182E+00
1506  THE INNER ANGLE, COS & SIN=   184.79   -0.13137834E+00   0.99155823E+00
1504  THE INNER ANGLE, COS & SIN=   178.91   -0.10457525E+00   0.99465945E+00
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OUTPUT INFORMATION WILL BE PROVIDED AS FOLLOWS :



ELEVATION RECORDING STATION OUTPUT :

    NOUTE =  1

    DATA RECORDS WILL START AFTER TOUTSE =  30.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR    28800 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFE =  44.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR    42240 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 61 EVERY NSPOOLE =      5 TIME STEPS

    UNIT 61 FORMAT WILL BE ASCII



    NUMBER OF INPUT ELEVATION RECORDING STATIONS =    20

    STATION   ELEMENT   LAMBDA(DEG)     FEA(DEG)         XCP             YCP

       1       1289    -81.80000300   24.71600000    -33814267.38     2751402.47
       2       1540    -81.80000300   26.12999700    -33814267.38     2908809.61
       3       2570    -83.03160200   29.13000400    -33934179.89     3242772.50
       4       4274    -84.18299800   30.06599700    -34046283.59     3346967.89
       5       4594    -85.75000000   30.13277300    -34198852.04     3354401.45
       6       6542    -88.84999800   30.39802600    -34500678.01     3383929.60
       7       5393    -89.16600000   30.23300200    -34531445.00     3365559.01
       8       5839    -89.31955500   30.27068300    -34546395.62     3369753.68
       9       2456    -89.42800100   28.92999900    -34556954.28     3220507.80
      10       2702    -91.44999700   29.28600400    -34753822.44     3260138.53
      11       2683    -94.79000100   29.30000700    -35079016.19     3261697.35
      12       1947    -97.05799900   27.82500400    -35299835.91     3097498.98
      13       1525    -97.15000100   26.06600200    -35308793.53     2901685.64
      14        733    -97.71131300   22.21600700    -35363444.70     2473101.50
      15          1    -94.41200300   18.23369700    -35042213.06     2029787.95
      16        230    -90.64202600   19.85031200    -34675155.74     2209750.67
      17        478    -89.65000200   21.31748000    -34578569.03     2373076.84
      18        975    -82.36660000   23.16576400    -33869433.12     2578829.11
      19       1341    -89.65000200   24.76000400    -34578569.03     2756301.03
      20       1723    -84.24999900   26.70000100    -34052807.02     2972262.86



VELOCITY RECORDING STATION OUTPUT :
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NOUTV =  1

DATA RECORDS WILL START AFTER TOUTSV =  38.000 DAY(S) RELATIVE
    TO THE STARTING TIME OR    36480 TIME STEPS INTO THE SIMULATION

DATA RECORDS WILL STOP AFTER TOUTFV =  44.000 DAY(S) RELATIVE
    TO THE STARTING TIME OR    42240 TIME STEPS INTO THE SIMULATION

INFORMATION WILL BE SPOOLED TO UNIT 62 EVERY  NSPOOLV =       5 TIME STEPS

UNIT 62 FORMAT WILL BE ASCII



NUMBER OF INPUT VELOCITY RECORDING STATIONS =    20
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STATION	ELEMENT	LAMBDA(DEG)	FEA(DEG)	XCP	YCP
1	4321	-89.46160100	30.07960100	-34560225.69	3348482.30
2	4573	-89.44300100	30.11280900	-34558414.73	3352179.04
3	4964	-89.45030200	30.16229800	-34559125.58	3357688.19
4	5141	-89.16120100	30.19650400	-34530977.76	3361496.02
5	6192	-89.11029800	30.32200600	-34526021.67	3375467.00
6	5653	-89.13729900	30.26100200	-34528650.58	3368675.99
7	5928	-89.02980000	30.29050900	-34518184.12	3371960.73
8	5167	-88.98660300	30.19920700	-34513978.32	3361796.92
9	5441	-88.82959700	30.24499900	-34498691.70	3366894.52
10	5431	-88.77899900	30.24300100	-34493765.32	3366672.10
11	6146	-88.77600100	30.31100900	-34493473.42	3374242.80
12	5767	-88.68029800	30.26900500	-34484155.46	3369566.89
13	5834	-88.51059700	30.26600700	-34467632.82	3369233.15
14	5079	-88.51249700	30.20750700	-34467817.81	3362720.89
15	5451	-88.45130100	30.24710000	-34461859.56	3367128.41
16	5282	-88.37300100	30.21960300	-34454236.02	3364067.42
17	5385	-88.32859800	30.22880000	-34449912.80	3365091.24
18	5973	-88.30079700	30.29150900	-34447206.00	3372072.05
19	5870	-88.12159700	30.29400700	-34429758.50	3372350.13
20	5270	-88.02899900	30.22950600	-34420742.86	3365169.83

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GLOBAL NODAL ELEVATION INFORMATION OUTPUT :

    NOUTGE =  1

    DATA RECORDS WILL START AFTER TOUTSGE =  40.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR    38400 TIME STEPS INTO THE SIMULATION
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    DATA RECORDS WILL STOP AFTER TOUTFGE =  41.000 DAY(S) RELATIVE
       TO THE STARTING TIME OR    39360 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 63 EVERY NSPOOLGE =      10 TIME STEPS

    UNIT 63 FORMAT WILL BE ASCII



 GLOBAL NODAL VELOCITY INFORMATION OUTPUT :

    NOUTGV =  1

    DATA RECORDS WILL START AFTER TOUTSGV =  40.000 DAY(S) RELATIVE
       TO THE STARTING TIME OR    38400 TIME STEPS INTO THE SIMULATION

    DATA RECORDS WILL STOP AFTER TOUTFGV =  41.000 DAY(S) RELATIVE
       TO THE STARTING TIME OR    39360 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE SPOOLED TO UNIT 64 EVERY NSPOOLGV =      10 TIME STEPS

    UNIT 64 FORMAT WILL BE ASCII



 HARMONIC ANALYSIS INFORMATION OUTPUT :

    HARMONIC ANALYSIS PERFORMED FOR   22 CONSTITUENTS


      FREQUENCY     NODAL FACTOR      EQU.ARG(DEG) CONSTITUENT

    0.000000000000   1.0000000          0.000         STEADY
    0.000004925202   1.0000000          0.000         SM
    0.000072921166   1.0000000          0.000         K1
    0.000067597751   1.0000000          0.000         O1
    0.000072522946   1.0000000          0.000         P1
    0.000077846368   1.0000000          0.000         SO1
    0.000135593715   1.0000000          0.000         2MS2
    0.000140518917   1.0000000          0.000         M2
    0.000145444119   1.0000000          0.000         S2
    0.000145842332   1.0000000          0.000         K2
    0.000150369322   1.0000000          0.000         2SM2
    0.000208116668   1.0000000          0.000         MO3
    0.000213041871   1.0000000          0.000         SO3/MK3
    0.000218365285   1.0000000          0.000         SK3
    0.000276112632   1.0000000          0.000         3MS4
```

```
    0.000281037834   1.0000000          0.000         M4
    0.000285963037   1.0000000          0.000         MS4
    0.000421556751   1.0000000          0.000         M6
    0.000426481954   1.0000000          0.000         2MS6
    0.000431407156   1.0000000          0.000         2SM6
    0.000562075668   1.0000000          0.000         M8
    0.000567000871   1.0000000          0.000         3MS8

    HARMONIC ANALYSIS WILL START AFTER THAS =  14.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR    13440 TIME STEPS INTO THE SIMULATION

    HARMONIC ANALYSIS WILL STOP AFTER THAF =  44.000 DAY(S) RELATIVE
        TO THE STARTING TIME OR    42240 TIME STEPS INTO THE SIMULATION

    INFORMATION WILL BE ANALYZED EVERY NHAINC =      20 TIME STEPS.

    MEANS AND VARIANCES WILL BE COMPUTED FOR THE FINAL   25.00000 %
        OF THE HARMONIC ANALYSIS PERIOD OR AFTER      35040 TIME STEPS INTO THE
                                            SIMULATION.
         RESULTS ARE WRITTEN TO UNIT 55.



    STATION ELEVATION HARMONIC ANAL WILL BE WRITTEN TO UNIT 51



    STATION VELOCITY HARMONIC ANAL WILL BE WRITTEN TO UNIT 52



    GLOBAL ELEVATION HARMONIC ANAL WILL BE WRITTEN TO UNIT 53



    GLOBAL VELOCITY HARMONIC ANAL WILL BE WRITTEN TO UNIT 54



HOT START OUTPUT INFORMATION OUTPUT :

    HOT START OUTPUT WILL BE WRITTEN TO UNIT 67 OR 68 EVERY   200 TIME STEPS


SOLVER INFORMATION OUTPUT :

    THE JCG ITERATIVE SOLVER WILL BE USED
```

```
NON TIME DEPENDENT COEFF AND MARTIX ASSEMBLY SECTION, INCL MATRIX CONDITIONING


THE NEIGHBOR TABLE IS BEING COMPUTED

THE NEIGHBOR TABLE IS COMPLETED
    THE MINIMUM NUMBER OF NEIGHBORS FOR ANY NODE =   3
    1+THE MAXIMUM NUMBER OF NEIGHBORS FOR ANY NODE =  10
    IN FUTURE RUNS THE PARAMETER MNEI CAN BE SET =  10
```

```
LIMITED RUNTIME INFORMATION SECTION


HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =   200 TIME =  0.18000000E+05
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =   400 TIME =  0.36000000E+05
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =   600 TIME =  0.54000000E+05
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP =   800 TIME =  0.72000000E+05
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP =  1000 TIME =  0.90000000E+05
```

This portion of the output file has been eliminated

```
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP = 41200 TIME =  0.37080000E+07
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP = 41400 TIME =  0.37260000E+07
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP = 41600 TIME =  0.37440000E+07
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP = 41800 TIME =  0.37620000E+07
HOT START OUTPUT WRITTEN TO UNIT 68 AT TIME STEP = 42000 TIME =  0.37800000E+07
HOT START OUTPUT WRITTEN TO UNIT 67 AT TIME STEP = 42200 TIME =  0.37980000E+07



    THE LARGEST VALUES OF THE RATIO RESYNTHESIZED TIME SERIES/RAW TIME SERIES:

          AVERAGE ELEVATION RATIO =   0.7183283E+02 AT NODE     2746
         VARIANCE ELEVATION RATIO =   0.1008504E+01 AT NODE     2394
         AVERAGE U VELOCITY RATIO =   0.1679997E+03 AT NODE     3657
        VARIANCE U VELOCITY RATIO =   0.1389307E+01 AT NODE     2527
         AVERAGE V VELOCITY RATIO =   0.3980537E+02 AT NODE     2777
        VARIANCE V VELOCITY RATIO =   0.1389307E+01 AT NODE     2527


    THE LOWEST VALUES OF THE RATIO RESYNTHESIZED TIME SERIES/RAW TIME SERIES:

          AVERAGE ELEVATION RATIO =  -0.3044245E+02 AT NODE     3201
         VARIANCE ELEVATION RATIO =   0.8539837E+00 AT NODE     3883
         AVERAGE U VELOCITY RATIO =  -0.8363093E+02 AT NODE     1261
```

```
          VARIANCE U VELOCITY RATIO =   0.5456080E+00 AT NODE      3531
           AVERAGE V VELOCITY RATIO =  -0.2866435E+02 AT NODE      1196
          VARIANCE V VELOCITY RATIO =   0.5456080E+00 AT NODE      3531
```

Sample Output File for Example 2 to UNIT 51

```
22
    0.0000000000E+00  1.0000000   0.00000000   STEADY
    0.4925202335E-05  1.0000000   0.00000000   SM
    0.7292116592E-04  1.0000000   0.00000000   K1
    0.6759775116E-04  1.0000000   0.00000000   O1
    0.7252294600E-04  1.0000000   0.00000000   P1
    0.7784636826E-04  1.0000000   0.00000000   SO1
    0.1355937147E-03  1.0000000   0.00000000   2MS2
    0.1405189171E-03  1.0000000   0.00000000   M2
    0.1454441194E-03  1.0000000   0.00000000   S2
    0.1458423318E-03  1.0000000   0.00000000   K2
    0.1503693218E-03  1.0000000   0.00000000   2SM2
    0.2081166682E-03  1.0000000   0.00000000   MO3
    0.2130418706E-03  1.0000000   0.00000000   SO3/MK3
    0.2183652853E-03  1.0000000   0.00000000   SK3
    0.2761126318E-03  1.0000000   0.00000000   3MS4
    0.2810378342E-03  1.0000000   0.00000000   M4
    0.2859630365E-03  1.0000000   0.00000000   MS4
    0.4215567512E-03  1.0000000   0.00000000   M6
    0.4264819536E-03  1.0000000   0.00000000   2MS6
    0.4314071559E-03  1.0000000   0.00000000   2SM6
    0.5620756683E-03  1.0000000   0.00000000   M8
    0.5670008707E-03  1.0000000   0.00000000   3MS8
20
1
  -0.34349983E-04       0.0000
   0.17581495E-03      36.6581
   0.93605271E-01     357.7578
   0.93251327E-01     358.3142
   0.29147091E-01       3.6829
   0.53803008E-03     114.8401
   0.10407962E-02     203.0090
   0.18341107E+00      72.3859
   0.59176749E-01      93.8027
   0.64001898E-03     233.8632
   0.47696483E-03     219.4560
   0.11271778E-02     335.3437
   0.16501572E-02     340.8963
   0.41704548E-03      56.9659
   0.13970857E-03     220.4125
   0.53111667E-03      46.5554
   0.25085123E-03      39.9293
   0.56087096E-03     249.2871
   0.54331521E-03     287.1007
   0.14274486E-03     322.1324
   0.68092659E-04     206.3808
   0.98331309E-04     240.6909
```

```
2
    0.28434600E-02       0.0000
    0.20627846E-02     325.2942
    0.15450742E+00      22.3863
    0.12834888E+00      12.7131
    0.33488858E-01      16.8497
    0.51082792E-02     120.3718
    0.14006376E-01     212.6416
    0.35645603E+00     100.3972
    0.14263618E+00     114.7295
    0.56490367E-02     242.6502
    0.45618706E-02     234.2112
    0.14857815E-01      21.1823
    0.19495609E-01       6.9063
    0.51194660E-02      79.2145
    0.62292788E-03     168.4887
    0.36970177E-02     107.2252
    0.46766548E-02     106.4725
    0.20014735E-02      44.8393
    0.22596031E-02      69.1131
    0.82796314E-03      80.2328
    0.34475528E-03     127.6115
    0.43639270E-03      90.7528
3
    0.16311832E-02       0.0000
    0.17825254E-02     311.2515
    0.19345059E+00      53.7612
    0.15305351E+00      35.2558
    0.39609112E-01      41.1327
    0.95521515E-02     161.5267
    0.49239422E-01     354.3277
    0.44749493E+00     203.1792
    0.14742962E+00     221.4802
    0.10196622E-01      37.3563
    0.69433514E-02      62.4228
    0.92253264E-02     217.4693
    0.10261507E-01     195.9359
    0.28893735E-02     263.4578
    0.20010862E-02     143.7566
    0.97244085E-02     338.5032
    0.42638861E-02       4.2745
    0.38032292E-02     257.1939
    0.46538164E-02     281.4247
    0.11941263E-02     313.2223
    0.58070169E-03     339.5211
    0.18801992E-02     338.8622
```

This portion of the output file has been eliminated

```
18
    0.23041213E-03       0.0000
    0.17985569E-03     321.7670
    0.88621059E-01       8.5936
    0.10052535E+00       4.2381
    0.26088429E-01       9.1959
    0.64543102E-04     202.2951
    0.17586008E-04     200.1031
    0.12633000E+00      46.8183
    0.39617738E-01      70.8264
    0.45316726E-04     356.7394
    0.42240754E-05     322.2650
    0.16002346E-04     101.0801
```

```
       0.17488529E-04      90.6581
       0.55561707E-05     138.3417
       0.36465324E-05      48.0404
       0.83239004E-05     253.4430
       0.13359461E-04     307.3503
       0.48362312E-05     215.4558
       0.39768097E-05     241.7926
       0.31278810E-06     139.9097
       0.17859275E-05     152.9676
       0.12495841E-05     134.5049
  19
      -0.41580557E-03       0.0000
       0.42973381E-03     288.8783
       0.15431675E+00      46.5853
       0.12702872E+00      26.1013
       0.31256144E-01      30.0777
       0.24278501E-02     155.3793
       0.97461095E-03     154.7774
       0.17220708E-01     181.8834
       0.51172513E-02     150.9268
       0.11330281E-02     326.1206
       0.17971103E-03     269.0007
       0.33887009E-03      74.4033
       0.32731990E-03      65.7644
       0.82313535E-04     114.1189
       0.45286291E-04      61.7756
       0.75680880E-04     227.0553
       0.11489728E-03     303.0595
       0.68748402E-04     248.7857
       0.95081004E-04     306.1936
       0.23437561E-04      31.5162
       0.21546971E-04     168.1712
       0.28843428E-04     171.5226
  20
      -0.25641327E-03       0.0000
       0.65435416E-03     257.3465
       0.14459563E+00      32.8081
       0.12026681E+00      15.4361
       0.30976227E-01      19.4326
       0.20392542E-02     137.8090
       0.10787869E-02     276.9013
       0.83500279E-01      97.7046
       0.36169690E-01      99.2146
       0.12771397E-02     300.7939
       0.23219683E-03     279.3505
       0.71241091E-03     122.8654
       0.93164926E-03     119.4154
       0.18615098E-03     189.7494
       0.27051279E-03       7.9141
       0.59067647E-03     248.6875
       0.75761946E-03     289.6912
       0.25093407E-03     148.6085
       0.35063162E-03     176.3163
       0.91009485E-04     216.5275
       0.30308981E-04      76.6279
       0.51388687E-04      66.6239
```

Sample Output File for Example 2 to UNIT 52

```
22
     0.0000000000E+00  1.0000000   0.00000000   STEADY
     0.4925202335E-05  1.0000000   0.00000000   SM
     0.7292116592E-04  1.0000000   0.00000000   K1
     0.6759775116E-04  1.0000000   0.00000000   O1
     0.7252294600E-04  1.0000000   0.00000000   P1
     0.7784636826E-04  1.0000000   0.00000000   SO1
     0.1355937147E-03  1.0000000   0.00000000   2MS2
     0.1405189171E-03  1.0000000   0.00000000   M2
     0.1454441194E-03  1.0000000   0.00000000   S2
     0.1458423318E-03  1.0000000   0.00000000   K2
     0.1503693218E-03  1.0000000   0.00000000   2SM2
     0.2081166682E-03  1.0000000   0.00000000   MO3
     0.2130418706E-03  1.0000000   0.00000000   SO3/MK3
     0.2183652853E-03  1.0000000   0.00000000   SK3
     0.2761126318E-03  1.0000000   0.00000000   3MS4
     0.2810378342E-03  1.0000000   0.00000000   M4
     0.2859630365E-03  1.0000000   0.00000000   MS4
     0.4215567512E-03  1.0000000   0.00000000   M6
     0.4264819536E-03  1.0000000   0.00000000   2MS6
     0.4314071559E-03  1.0000000   0.00000000   2SM6
     0.5620756683E-03  1.0000000   0.00000000   M8
     0.5670008707E-03  1.0000000   0.00000000   3MS8
20
1
    0.53874384E-02     0.0000    0.30733988E-03      0.0000
    0.34371668E-02    50.0847    0.33744966E-03     37.7495
    0.16169003E+00   209.0067    0.12541679E-01    213.9738
    0.11626025E+00   188.7696    0.91913493E-02    192.9617
    0.32741346E-01   186.0356    0.23034865E-02    191.6780
    0.15893022E-01   341.4360    0.10206285E-02    323.1748
    0.14430389E-01   165.3712    0.11110071E-02    161.1661
    0.67936448E-01   338.8835    0.58440349E-02    346.1076
    0.37674869E-01   338.6571    0.32275063E-02    340.9944
    0.22115878E-01   174.2381    0.19059731E-02    167.2169
    0.73229968E-02   158.0001    0.57964895E-03    144.6167
    0.14492128E-01    27.7342    0.15714877E-02     22.6763
    0.35431124E-01   351.2825    0.34389212E-02    344.2494
    0.87075176E-02    57.5949    0.97877589E-03     49.6632
    0.15904174E-02    55.1092    0.18392194E-03     48.4020
    0.90782578E-02   238.5808    0.98492782E-03    237.1526
    0.10015380E-01   188.5011    0.10151525E-02    183.7869
    0.17979169E-02   127.1353    0.24581249E-03    128.8932
    0.45721149E-02    70.9355    0.52645012E-03     72.7855
    0.12264285E-02   105.1808    0.13617476E-03     96.7232
    0.72477099E-03     3.1012    0.96157678E-04      8.1375
    0.16371269E-02   310.9293    0.24165482E-03    314.0911
2
    0.57999798E-02     0.0000    0.56905453E-03      0.0000
    0.32588619E-02    38.1502    0.45006671E-03     29.9968
    0.15684607E+00   209.8626    0.25091330E-01    218.2044
    0.11249188E+00   188.5373    0.17795497E-01    195.6612
    0.31643501E-01   186.0067    0.47133465E-02    194.3045
    0.14940231E-01   345.5813    0.21155145E-02    342.8167
    0.12989016E-01   168.3688    0.21024895E-02    172.9069
```

```
      0.64044445E-01    340.1319    0.11813923E-01    354.7468
      0.34450586E-01    339.9127    0.62829341E-02    349.6290
      0.19119935E-01    176.8411    0.34734954E-02    175.8204
      0.59653043E-02    158.9322    0.87725263E-03    154.6889
      0.12415160E-01     29.8464    0.30802736E-02     31.0217
      0.29259782E-01    355.2258    0.64708204E-02    355.6836
      0.73186200E-02     58.3261    0.19212401E-02     53.2032
      0.12325577E-02     64.3784    0.43956923E-03     60.5385
      0.75524349E-02    239.3110    0.22310098E-02    244.7290
      0.79147789E-02    190.3516    0.20219236E-02    195.0759
      0.13350114E-02    129.0650    0.60003564E-03    134.3816
      0.31392236E-02     79.8756    0.11743971E-02     87.7255
      0.75193152E-03    114.4432    0.23913413E-03    114.5585
      0.41980493E-03      0.4354    0.19984305E-03     18.8563
      0.96060891E-03    311.1786    0.59568694E-03    316.9919
 3
      0.43941684E-02      0.0000    0.43740997E-03      0.0000
      0.27633624E-02     39.2827    0.70964324E-03     58.1190
      0.15317868E+00    210.7737    0.57017117E-01    209.0541
      0.10927434E+00    188.9712    0.40085463E-01    187.3101
      0.31072319E-01    185.6160    0.11274563E-01    183.7506
      0.15494815E-01    348.4280    0.59178795E-02    344.0095
      0.12501068E-01    171.4296    0.49586370E-02    169.2427
      0.61923047E-01    341.8738    0.24297477E-01    342.0426
      0.32746194E-01    341.6465    0.12811057E-01    341.5437
      0.17775196E-01    178.9939    0.70758089E-02    176.6063
      0.53979211E-02    160.7957    0.20502775E-02    160.1366
      0.11923953E-01     30.5474    0.52412819E-02     27.6805
      0.27255135E-01    356.8574    0.11923710E-01    354.7357
      0.70015176E-02     56.9886    0.30757191E-02     51.8407
      0.12230295E-02     62.6739    0.63521698E-03     58.3019
      0.74852579E-02    239.2618    0.35459692E-02    237.3503
      0.75250721E-02    191.3912    0.34971789E-02    190.3965
      0.14521554E-02    126.0504    0.82427264E-03    123.9636
      0.30696902E-02     80.0800    0.16688617E-02     80.5232
      0.67057863E-03    113.5082    0.33299106E-03    112.4396
      0.42510848E-03    354.7589    0.25694412E-03      2.8895
      0.10454441E-02    301.9156    0.73187794E-03    305.5791
```

This portion of the output file has been eliminated

```
 18
      0.23159053E-02      0.0000    0.59623482E-03      0.0000
      0.92575311E-03      6.8594    0.55771487E-04     53.2149
      0.83596474E-01    345.5851    0.48965326E-01    314.5101
      0.60819056E-01    322.9192    0.34218100E-01    294.9824
      0.17255511E-01    320.5456    0.90301317E-02    293.0000
      0.62712777E-02    113.8157    0.38926469E-02     63.2564
      0.40490859E-02    294.6355    0.13986118E-02    258.6938
      0.30470206E-01     91.7073    0.24817655E-01     48.1764
      0.14674975E-01     88.6956    0.12094261E-01     41.6060
      0.51141539E-02    300.6215    0.18006541E-02    247.7251
      0.17361287E-02    286.8282    0.57474685E-03    218.6749
      0.38204185E-02    134.6377    0.11752833E-02     74.8355
      0.80766209E-02    111.2842    0.22008669E-02     64.4313
      0.15675183E-02    168.7654    0.45004586E-04     39.5616
      0.35420990E-03     88.6473    0.45575721E-03     51.8419
      0.25984608E-02    318.3120    0.85883522E-03    290.9910
      0.29880722E-02    317.2240    0.24475556E-02    338.6259
      0.44698987E-03     96.3091    0.92313283E-03    356.2321
      0.16191548E-02    111.7949    0.81031851E-03    111.5163
      0.44501928E-03    140.6398    0.25804122E-03    154.2155
```

```
      0.23900147E-03     17.3530    0.23355989E-03     57.8867
      0.34527663E-03      6.0585    0.66974605E-03     43.1883
   19
      0.48559544E-02      0.0000   -0.24324740E-02      0.0000
      0.33332356E-02    357.8937    0.13842601E-02    158.8255
      0.11527753E+00      2.0497    0.80956370E-01    341.6145
      0.81929398E-01    338.2420    0.59065133E-01    321.1158
      0.22994449E-01    330.7627    0.15562901E-01    315.0606
      0.11867087E-01    125.5248    0.86982659E-02     83.9496
      0.92247477E-02    306.3556    0.62951061E-02    281.8385
      0.48607644E-01    122.6438    0.34206368E-01     94.8405
      0.25384106E-01    123.7496    0.17731998E-01     95.2988
      0.12066182E-01    319.1426    0.82669225E-02    294.4216
      0.44117580E-02    298.3707    0.31477539E-02    277.6471
      0.93847699E-02    136.2038    0.58082740E-02    112.5928
      0.18725421E-01    108.7516    0.11776722E-01     86.1331
      0.42415706E-02    159.0675    0.25738220E-02    139.2790
      0.60426278E-03    134.5622    0.57348033E-03     69.4927
      0.50413706E-02    319.5829    0.39518736E-02    301.9684
      0.33076946E-02    255.9580    0.29810364E-02    269.1593
      0.23747026E-02    150.5326    0.11090536E-02    116.3496
      0.13331989E-02    115.0503    0.13554638E-02     83.4451
      0.20920485E-03    113.6371    0.31281257E-03     98.7298
      0.67352752E-03    319.7316    0.38674336E-03    305.8299
      0.15086214E-02    266.6061    0.73282594E-03    257.2924
   20
     -0.19239732E-01      0.0000   -0.55590250E-02      0.0000
      0.83501429E-02    160.4914    0.45373559E-02    173.0548
      0.96986242E-01    337.9079    0.26345105E+00    336.5696
      0.74529384E-01    317.8324    0.19387987E+00    317.4212
      0.19919890E-01    311.8078    0.50985716E-01    310.3305
      0.10713999E-01     78.2436    0.31357344E-01     78.6086
      0.66382868E-02    268.5691    0.18605151E-01    278.0162
      0.41445214E-01     87.7254    0.10118172E+00     80.3558
      0.20453477E-01     87.1207    0.51511291E-01     81.5892
      0.64137078E-02    285.7925    0.24269995E-01    294.6871
      0.41178809E-02    255.7028    0.85575210E-02    270.2589
      0.60372720E-02    107.8907    0.18780896E-01    100.6082
      0.11001938E-01     86.6742    0.36521304E-01     74.6434
      0.20011408E-02    125.1457    0.71887725E-02    130.0750
      0.68000494E-03     18.0335    0.20551917E-02     35.4878
      0.52332809E-02    274.6020    0.11226548E-01    269.3542
      0.41404911E-02    246.4230    0.92712693E-02    249.8902
      0.15566002E-02     54.8977    0.36045180E-02     54.1197
      0.17217724E-02     38.7960    0.45718016E-02     45.9832
      0.48190785E-03     51.0594    0.11627385E-02     70.5350
      0.37307055E-03    227.8210    0.94949991E-03    240.5710
      0.56222621E-03    169.5859    0.15495455E-02    187.6987
```

Sample Output File for Example 2 to UNIT 53

```
  22
      0.0000000000E+00  1.0000000   0.00000000       STEADY
      0.4925202335E-05  1.0000000   0.00000000   SM
```

```
     0.7292116592E-04  1.0000000   0.00000000   K1
     0.6759775116E-04  1.0000000   0.00000000   O1
     0.7252294600E-04  1.0000000   0.00000000   P1
     0.7784636826E-04  1.0000000   0.00000000   SO1
     0.1355937147E-03  1.0000000   0.00000000   2MS2
     0.1405189171E-03  1.0000000   0.00000000   M2
     0.1454441194E-03  1.0000000   0.00000000   S2
     0.1458423318E-03  1.0000000   0.00000000   K2
     0.1503693218E-03  1.0000000   0.00000000   2SM2
     0.2081166682E-03  1.0000000   0.00000000   MO3
     0.2130418706E-03  1.0000000   0.00000000   SO3/MK3
     0.2183652853E-03  1.0000000   0.00000000   SK3
     0.2761126318E-03  1.0000000   0.00000000   3MS4
     0.2810378342E-03  1.0000000   0.00000000   M4
     0.2859630365E-03  1.0000000   0.00000000   MS4
     0.4215567512E-03  1.0000000   0.00000000   M6
     0.4264819536E-03  1.0000000   0.00000000   2MS6
     0.4314071559E-03  1.0000000   0.00000000   2SM6
     0.5620756683E-03  1.0000000   0.00000000   M8
     0.5670008707E-03  1.0000000   0.00000000   3MS8
3939
1
    0.61232000E-03      0.0000
    0.74223575E-03    194.3795
    0.16001768E+00     38.5455
    0.12854063E+00     19.4142
    0.33243900E-01     24.4189
    0.27839171E-02    140.1200
    0.30625173E-02    103.3162
    0.34201594E-01     95.5127
    0.21175450E-01     83.1412
    0.87269962E-03    240.1011
    0.79331185E-03    180.8672
    0.13163525E-02    328.0084
    0.19479332E-02    303.8158
    0.58442124E-03      1.8820
    0.14869866E-02    357.1133
    0.39937006E-02    206.8941
    0.34141461E-02    292.2279
    0.51179209E-02     60.7478
    0.38590177E-02    127.2453
    0.10915230E-02    191.0609
    0.30283994E-03     48.2054
    0.80005532E-03     79.4893
2
    0.61271230E-03      0.0000
    0.74142692E-03    194.3833
    0.16005726E+00     38.5413
    0.12857423E+00     19.4096
    0.33251230E-01     24.4070
    0.27857127E-02    140.1180
    0.30641807E-02    103.3263
    0.34276114E-01     95.5676
    0.21210333E-01     83.1879
    0.87770614E-03    239.8346
    0.79380916E-03    180.8381
    0.13196701E-02    328.0077
    0.19527547E-02    303.8134
    0.58576897E-03    1.9367
    0.14919582E-02    357.1118
    0.40083568E-02    206.9248
    0.34260950E-02    292.2363
```

```
      0.51554209E-02   60.7783
      0.38889795E-02    127.3234
      0.11010013E-02    191.1464
      0.30746711E-03   48.3444
      0.81200575E-03   79.4970
  3
      0.61316405E-03  0.0000
      0.74287268E-03    194.3375
      0.16000063E+00   38.5618
      0.12852471E+00   19.4335
      0.33245263E-01   24.4442
      0.27823989E-02    140.1320
      0.30608509E-02    103.3339
      0.34222792E-01   95.4427
      0.21187445E-01   83.1168
      0.86898555E-03    240.3470
      0.79278830E-03    180.9132
      0.13141936E-02    328.0701
      0.19442894E-02    303.8776
      0.58334129E-03    1.9093
      0.14833631E-02    357.1706
      0.39827996E-02    206.9444
      0.34052703E-02    292.2871
      0.50899569E-02   60.8268
      0.38363805E-02    127.2925
      0.10842776E-02    191.1112
      0.29977022E-03   48.2817
      0.79143292E-03   79.6416
```

This portion of the output file has been eliminated

```
  3937
      0.22522284E-01       0.0000
      0.16784156E-01      13.6395
      0.31168755E-01     191.6340
      0.23797432E-01     169.0829
      0.69157305E-02     157.2811
      0.60353663E-02     329.0451
      0.10890088E-02     202.1356
      0.42374591E-02     329.3877
      0.19729668E-02     342.9615
      0.12303678E-02     226.8817
      0.17143046E-03     243.5433
      0.61830071E-03     204.8446
      0.12067249E-02     146.2375
      0.18079890E-03     216.7837
      0.86654525E-04     257.3305
      0.23216205E-03     331.5301
      0.27422251E-03     347.6915
      0.24104632E-03     128.8580
      0.10689490E-02     123.3249
      0.31612826E-03     186.6341
      0.88199240E-04     206.2087
      0.27959573E-03     162.5448
  3938
      0.22524506E-01       0.0000
      0.16789871E-01      13.7183
      0.31544820E-01     193.9410
      0.23956378E-01     171.3387
      0.69586807E-02     160.1212
      0.60656486E-02     331.0347
      0.11008082E-02     205.8601
```

```
      0.41333214E-02    323.1947
      0.18461145E-02    337.2875
      0.12508463E-02    230.5755
      0.17004241E-03    240.3130
      0.63235153E-03    211.3350
      0.12333913E-02    152.6645
      0.18590429E-03    223.5367
      0.90929963E-04    266.0086
      0.24750461E-03    340.7756
      0.29563346E-03    356.9597
      0.29753442E-03    146.1310
      0.13344131E-02    142.7246
      0.39357039E-03    206.5693
      0.50746602E-04    293.8031
      0.12871323E-03    263.8852
 3939
      0.22526405E-01      0.0000
      0.16788981E-01     13.7229
      0.31493742E-01    193.2942
      0.23955872E-01    170.7602
      0.69706938E-02    159.3922
      0.60583831E-02    330.5734
      0.11053348E-02    204.9153
      0.43657237E-02    323.3562
      0.19625232E-02    336.7467
      0.12558871E-02    229.5490
      0.17187621E-03    247.1276
      0.64367716E-03    209.8246
      0.12560450E-02    151.1779
      0.18922477E-03    221.9799
      0.94353583E-04    263.8717
      0.25641389E-03    338.4972
      0.30635855E-03    354.5978
      0.31683275E-03    142.7238
      0.14239249E-02    138.8766
      0.42069638E-03    202.7113
      0.54216012E-04    271.2010
      0.12946004E-03    233.3865
```

Sample Output File for Example 2 to UNIT 54

```
 22
      0.0000000000E+00  1.0000000   0.00000000      STEADY
      0.4925202335E-05  1.0000000   0.00000000   SM
      0.7292116592E-04  1.0000000   0.00000000   K1
      0.6759775116E-04  1.0000000   0.00000000   O1
      0.7252294600E-04  1.0000000   0.00000000   P1
      0.7784636826E-04  1.0000000   0.00000000   SO1
      0.1355937147E-03  1.0000000   0.00000000   2MS2
      0.1405189171E-03  1.0000000   0.00000000   M2
      0.1454441194E-03  1.0000000   0.00000000   S2
      0.1458423318E-03  1.0000000   0.00000000   K2
      0.1503693218E-03  1.0000000   0.00000000   2SM2
      0.2081166682E-03  1.0000000   0.00000000   MO3
```

```
    0.2130418706E-03  1.0000000   0.00000000   SO3/MK3
    0.2183652053E-03  1.0000000   0.00000000   SK3
    0.2761126318E-03  1.0000000   0.00000000   3MS4
    0.2810378342E-03  1.0000000   0.00000000   M4
    0.2859630365E-03  1.0000000   0.00000000   MS4
    0.4215567512E-03  1.0000000   0.00000000   M6
    0.4264819536E-03  1.0000000   0.00000000   2MS6
    0.4314071559E-03  1.0000000   0.00000000   2SM6
    0.5620756683E-03  1.0000000   0.00000000   M8
    0.5670008707E-03  1.0000000   0.00000000   3MS8
3939
1
  -0.99222588E-04     0.0000    0.16786940E-03     0.0000
   0.85941955E-04   314.6296    0.14540061E-03   134.6296
   0.24644254E-02   343.3388    0.41694298E-02   163.3388
   0.18708813E-02   325.1155    0.31652443E-02   145.1155
   0.51855603E-03   326.9565    0.87731728E-03   146.9565
   0.28889817E-04   124.1102    0.48877140E-04   304.1102
   0.61457580E-04    42.5454    0.10397680E-03   222.5454
   0.81733780E-03    31.4395    0.13828102E-02   211.4395
   0.52068798E-03    14.7202    0.88092421E-03   194.7202
   0.58521312E-04   164.0043    0.99009085E-04   344.0043
   0.19434525E-04   114.3048    0.32880237E-04   294.3048
   0.67113303E-04   241.1165    0.11354542E-03    61.1165
   0.93741225E-04   220.0352    0.15859578E-03    40.0352
   0.26612579E-04   276.8180    0.45024403E-04    96.8180
   0.66159075E-04   280.4403    0.11193101E-03   100.4403
   0.18864956E-03   129.9443    0.31916612E-03   309.9443
   0.15220564E-03   210.6992    0.25750861E-03    30.6992
   0.32827583E-03   339.3704    0.55539236E-03   159.3704
   0.25084705E-03    48.9620    0.42439474E-03   228.9620
   0.77078861E-04   113.3831    0.13040561E-03   293.3831
   0.28157929E-04   321.0305    0.47638898E-04   141.0305
   0.71028479E-04   353.6084    0.12016929E-03   173.6084
2
  -0.70161417E-04     0.0000    0.18890605E-04     0.0000
   0.57377827E-04   312.3224    0.15448688E-04   132.3224
   0.26904829E-02     4.1305    0.72439884E-03   184.1305
   0.21721819E-02   346.0248    0.58484894E-03   166.0248
   0.56983759E-03   350.3886    0.15342587E-03   170.3886
   0.19257286E-04    77.5808    0.51849263E-05   257.5808
   0.57805490E-04    59.9548    0.15563834E-04   239.9548
   0.73394289E-03    43.5254    0.19761039E-03   223.5254
   0.46468359E-03    26.8217    0.12511369E-03   206.8217
   0.53578523E-04   168.5744    0.14425745E-04   348.5744
   0.17382856E-04   113.2691    0.46802456E-05   293.2691
   0.62843860E-04   246.1070    0.16920390E-04    66.1070
   0.93405222E-04   222.3184    0.25148881E-04    42.3184
   0.26618886E-04   275.2962    0.71669998E-05    95.2962
   0.60432003E-04   283.6127    0.16271010E-04   103.6127
   0.16875289E-03   134.5437    0.45435857E-04   314.5437
   0.13387775E-03   218.5621    0.36045903E-04    38.5621
   0.28562243E-03   344.4430    0.76902386E-04   164.4430
   0.22541756E-03    55.0935    0.60692532E-04   235.0935
   0.69535844E-04   118.8831    0.18722172E-04   298.8831
   0.25778963E-04   326.1510    0.69408548E-05   146.1510
   0.63561071E-04   357.6845    0.17113495E-04   177.6845
3
  -0.72443810E-04     0.0000    0.77085651E-04     0.0000
   0.22180826E-04   182.4770    0.33353550E-04    62.4227
   0.18963192E-02   330.2213    0.42351629E-02   137.4582
   0.13916986E-02   311.6180    0.32107714E-02   118.1867
```

```
   0.39037372E-03   312.4826   0.91326740E-03   120.8441
   0.32679726E-04    76.9901   0.74114554E-04   237.3715
   0.50268627E-04    38.0120   0.11799930E-03   204.2286
   0.70210349E-03    23.7177   0.16071790E-02   192.8552
   0.45277559E-03     7.3909   0.10475200E-02   176.5190
   0.54411233E-04   159.2461   0.13159305E-03   333.6405
   0.17911059E-04   102.4100   0.43130523E-04   272.7866
   0.59875607E-04   237.3918   0.12535885E-03    53.7646
   0.87304618E-04   214.9521   0.18747760E-03    31.3970
   0.24915273E-04   270.7230   0.55873359E-04    86.2475
   0.59644747E-04   278.7676   0.14289089E-03    88.1020
   0.16532186E-03   128.8320   0.41304795E-03   297.7683
   0.13443885E-03   210.0536   0.32865657E-03    20.0497
   0.28118377E-03   339.7693   0.73086413E-03   151.4607
   0.21522539E-03    49.0977   0.56355006E-03   221.1873
   0.66868241E-04   114.3613   0.17198751E-03   286.0965
   0.24175386E-04   324.4551   0.63066068E-04   137.3241
   0.60710941E-04   355.0617   0.16136880E-03   168.3868
```

This portion of the output file has been eliminated

```
3937
   0.83180225E-04     0.0000   0.10905926E-03     0.0000
   0.59767514E-03   116.0358   0.78362385E-03   116.0358
   0.46192889E-02   350.3527   0.60564422E-02   350.3527
   0.35185226E-02   327.1401   0.46132055E-02   327.1401
   0.11514864E-02   317.3467   0.15097369E-02   317.3467
   0.95073914E-03   136.7809   0.12465331E-02   136.7809
   0.17716315E-03     4.4905   0.23228216E-03     4.4905
   0.47239370E-03   116.2608   0.61936485E-03   116.2608
   0.18457573E-03   133.9052   0.24200094E-03   133.9052
   0.19296772E-03    18.3230   0.25300384E-03    18.3230
   0.23256601E-04    42.3192   0.30492196E-04    42.3192
   0.10119050E-03   354.7918   0.13267289E-03   354.7918
   0.20850116E-03   294.5837   0.27337006E-03   294.5837
   0.30769287E-04     2.4758   0.40342229E-04     2.4758
   0.18548146E-04    41.0464   0.24318846E-04    41.0464
   0.48045922E-04   121.6947   0.62993972E-04   121.6947
   0.61255428E-04   135.8231   0.80313219E-04   135.8231
   0.94605697E-04   268.5081   0.12403943E-03   268.5081
   0.44981157E-03   265.2227   0.58975697E-03   265.2227
   0.13276358E-03   329.4186   0.17406900E-03   329.4186
   0.60290971E-04    75.6018   0.79048700E-04    75.6018
   0.19678604E-03    42.5173   0.25801013E-03    42.5173
3938
   0.24086685E-04     0.0000  -0.42482145E-04     0.0000
   0.10147632E-03   207.9221   0.17897572E-03    27.9221
   0.23397167E-02   206.8653   0.41266029E-02    26.8653
   0.17291969E-02   180.4434   0.30498176E-02     0.4434
   0.58340998E-03   170.1008   0.10289713E-02   350.1008
   0.51888682E-03   352.3918   0.91517057E-03   172.3918
   0.11218736E-03   246.3646   0.19786699E-03    66.3646
   0.37768756E-03    12.1675   0.66613475E-03   192.1675
   0.16494188E-03    31.0054   0.29091114E-03   211.0054
   0.12101957E-03   272.4574   0.21344452E-03    92.4574
   0.21236241E-04   309.3854   0.37454764E-04   129.3854
   0.80634729E-04   259.9024   0.14221701E-03    79.9024
   0.16372381E-03   202.7507   0.28876281E-03    22.7507
   0.24577910E-04   271.9027   0.43348529E-04    91.9027
   0.16384206E-04   331.1724   0.28897137E-04   151.1724
   0.43855566E-04    38.4533   0.77348897E-04   218.4533
   0.50948872E-04    54.6337   0.89859496E-04   234.6337
```

```
    0.62846415E-04    213.0896    0.11084342E-03     33.0896
    0.29622727E-03    207.8177    0.52246167E-03     27.8177
    0.87393001E-04    272.3853    0.15413670E-03     92.3853
    0.23160752E-04    306.9862    0.40849060E-04    126.9862
    0.71908506E-04    261.4687    0.12682640E-03     81.4687
3939
   -0.31277157E-06      0.0000   -0.10497522E-05      0.0000
    0.99261407E-04     93.8758    0.33315009E-03     93.8758
    0.11422318E-02      4.1551    0.38336616E-02      4.1551
    0.89320541E-03    341.7494    0.29978566E-02    341.7494
    0.28236538E-03    331.4114    0.94770018E-03    331.4114
    0.22296711E-03    147.1234    0.74834234E-03    147.1234
    0.47370021E-04     22.8167    0.15898754E-03     22.8167
    0.13575866E-03    142.8738    0.45564547E-03    142.8738
    0.52646302E-04    161.9780    0.17669627E-03    161.9780
    0.47807625E-04     43.1611    0.16045627E-03     43.1611
    0.72098938E-05     76.3911    0.24198496E-04     76.3911
    0.26937746E-04     25.2078    0.90410896E-04     25.2078
    0.55172653E-04    327.6390    0.18517544E-03    327.6390
    0.78475353E-05     33.3878    0.26338606E-04     33.3878
    0.42811362E-05     81.9607    0.14368736E-04     81.9607
    0.11955643E-04    158.9050    0.40126608E-04    158.9050
    0.14392302E-04    173.3305    0.48304744E-04    173.3305
    0.16943258E-04    311.0424    0.56866491E-04    311.0424
    0.83325882E-04    307.0260    0.27966585E-03    307.0260
    0.24574486E-04     11.0024    0.82479107E-04     11.0024
    0.15858631E-04     91.7642    0.53226170E-04     91.7642
    0.52402030E-04     54.7004    0.17587642E-03     54.7004
```

Sample Output File for Example 2 to UNIT 55

```
3939
1
  -0.11468652E-02  -0.13777120E-02   0.12012850E+01    0.32224440E-01   0.32230891E-01   0.10002002E+01
   0.14631090E-04   0.65311959E-05   0.44639160E+00    0.83059085E-05   0.79889889E-05   0.96184408E+00
  -0.24753561E-04  -0.11049782E-04   0.44639160E+00    0.23774376E-04   0.22867243E-04   0.96184408E+00
2
  -0.11475401E-02  -0.13789550E-02   0.12016617E+01    0.32245061E-01   0.32250337E-01   0.10001636E+01
  -0.20400212E-05  -0.74108825E-05   0.36327479E+01    0.98157272E-05   0.95904767E-05   0.97705208E+00
   0.54926532E-06   0.19953424E-05   0.36327479E+01    0.71156979E-06   0.69524074E-06   0.97705208E+00
3
  -0.11491602E-02  -0.13795702E-02   0.12005029E+01    0.32216815E-01   0.32224126E-01   0.10002269E+01
   0.29276582E-05   0.15363559E-05   0.52477295E+00    0.49412459E-05   0.47007495E-05   0.95132880E+00
  -0.13405145E-03  -0.12687889E-03   0.94649399E+00    0.25640368E-04   0.24040774E-04   0.93761420E+00
4
  -0.11442258E-02  -0.13742878E-02   0.12010[illegible]01    0.32189282E-01   0.32198171E-01   0.10002761E+01
   0.75712746E-04   0.70193087E-04   0.927[illegible]00    0.13913268E-04   0.13251005E-04   0.95240062E+00
  -0.12869296E-03  -0.11931091E-03   0.92709736E+00    0.40197660E-04   0.38284276E-04   0.95240062E+00
5
  -0.11516998E-02  -0.13831897E-02   0.12009985E+01    0.32262359E-01   0.32267632E-01   0.10001634E+01
  -0.29646125E-03  -0.30012545E-03   0.10123598E+01    0.13121082E-04   0.13097276E-04   0.99818571E+00
  -0.13850883E-03  -0.14022077E-03   0.10123598E+01    0.28641033E-05   0.28589070E-05   0.99818571E+00
6
  -0.11530781E-02  -0.13834153E-02   0.11997585E+01    0.32231601E-01   0.32238707E-01   0.10002205E+01
```

```
   -0.98067651E-05  -0.12282002E-04   0.12524010E+01    0.47026398E-05   0.45653961E-05   0.97081560E+00
   -0.24489159E-03  -0.23753514E-03   0.96996040E+00    0.18179984E-04   0.16668407E-04   0.91685489E+00
 7
   -0.11480326E-02  -0.13767629E-02   0.11992368E+01    0.32146833E-01   0.32158658E-01   0.10003678E+01
    0.47213461E-04   0.42069473E-04   0.89104828E+00    0.62012802E-05   0.58608563E-05   0.94510425E+00
   -0.25803142E-03  -0.24673830E-03   0.95623352E+00    0.64757583E-04   0.60172923E-04   0.92920273E+00
 8
   -0.11557651E-02  -0.13844632E-02   0.11978759E+01    0.32180284E-01   0.32191006E-01   0.10003332E+01
    0.89565550E-04   0.87031220E-04   0.97170419E+00    0.60368656E-05   0.57380054E-05   0.95049416E+00
   -0.39878860E-03  -0.38596890E-03   0.96785338E+00    0.69235904E-04   0.64845090E-04   0.93658183E+00
 9
   -0.11380683E-02  -0.13669616E-02   0.12011244E+01    0.32137397E-01   0.32149406E-01   0.10003737E+01
    0.14534075E-04   0.13236247E-04   0.91070444E+00    0.83291457E-05   0.78110547E-05   0.93779782E+00
   -0.43250440E-04  -0.39388368E-04   0.91070444E+00    0.73757592E-04   0.69169709E-04   0.93779782E+00
 10
   -0.11572316E-02  -0.13883541E-02   0.11997202E+01    0.32283878E-01   0.32289528E-01   0.10001750E+01
   -0.13313122E-03  -0.13315499E-03   0.10001785E+01    0.40139939E-05   0.39285780E-05   0.97872047E+00
   -0.33597179E-03  -0.33603177E-03   0.10001785E+01    0.25563630E-04   0.25019648E-04   0.97872047E+00
```

This portion of the output file has been eliminated

```
 3930
    0.18182123E-01   0.18171324E-01   0.99940610E+00    0.14184204E-02   0.12979976E-02   0.91510075E+00
    0.14659770E-03   0.17799230E-03   0.12141548E+01    0.32471175E-04   0.30997315E-04   0.95461019E+00
    0.54993308E-04   0.35925128E-04   0.65326363E+00    0.64100515E-05   0.61822458E-05   0.96446118E+00
 3931
    0.18168066E-01   0.18150367E-01   0.99902582E+00    0.14403940E-02   0.13192016E-02   0.91586167E+00
   -0.13233752E-03  -0.95143985E-04   0.71894945E+00    0.35764204E-04   0.34371673E-04   0.96106356E+00
   -0.10194698E-03  -0.73294723E-04   0.71894945E+00    0.21224199E-04   0.20397804E-04   0.96106356E+00
 3932
    0.18159825E-01   0.18137601E-01   0.99877624E+00    0.14221259E-02   0.13015073E-02   0.91518433E+00
   -0.20768634E-03  -0.12152306E-03   0.58512784E+00    0.60647783E-04   0.58208795E-04   0.95978438E+00
   -0.72690683E-05  -0.42533342E-05   0.58512784E+00    0.74294478E-07   0.71306680E-07   0.95978438E+00
 3933
    0.18223696E-01   0.18220100E-01   0.99980270E+00    0.13975769E-02   0.12778999E-02   0.91436822E+00
   -0.72500709E-04   0.80141575E-04  -0.11053902E+01    0.79499633E-04   0.76540675E-04   0.96278024E+00
    0.11783366E-04  -0.13025217E-04  -0.11053902E+01    0.21000002E-05   0.20218387E-05   0.96278024E+00
 3934
    0.18231471E-01   0.18230332E-01   0.99993754E+00    0.14486781E-02   0.13273565E-02   0.91625359E+00
    0.21889319E-04   0.16383715E-03   0.74847989E+01    0.55520625E-04   0.53310528E-04   0.96019322E+00
   -0.80684906E-05  -0.60391030E-04   0.74847989E+01    0.75435270E-05   0.72432435E-05   0.96019322E+00
 3935
    0.18208019E-01   0.18201439E-01   0.99963862E+00    0.14501477E-02   0.13285584E-02   0.91615387E+00
    0.14758086E-03   0.17379597E-03   0.11776321E+01    0.22340785E-04   0.21380039E-04   0.95699589E+00
    0.23238448E-04  -0.11875956E-05  -0.51104774E-01    0.24561649E-05   0.22992362E-05   0.93610825E+00
 3936
    0.18199024E-01   0.18191748E-01   0.99960021E+00    0.14671714E-02   0.13449338E-02   0.91668484E+00
   -0.13869435E-03  -0.15312109E-03   0.11040182E+01    0.20914740E-04   0.20125954E-04   0.96228562E+00
   -0.15296062E-03  -0.16887131E-03   0.11040182E+01    0.25438657E-04   0.24479254E-04   0.96228562E+00
 3937
    0.18181915E-01   0.18168728E-01   0.99927473E+00    0.14552059E-02   0.13334950E-02   0.91636173E+00
   -0.10557646E-03  -0.99131568E-04   0.93895521E+00    0.28325454E-04   0.27235981E-04   0.96153729E+00
   -0.13842341E-03  -0.12997339E-03   0.93895521E+00    0.48692470E-04   0.46819626E-04   0.96153729E+00
 3938
    0.18223039E-01   0.18219888E-01   0.99982707E+00    0.14755923E-02   0.13532204E-02   0.91706933E+00
    0.22999673E-04   0.61406199E-04   0.26698727E+01    0.69181926E-05   0.66760770E-05   0.96500306E+00
   -0.40564962E-04  -0.10830328E-03   0.26698727E+01    0.21520456E-04   0.20767306E-04   0.96500306E+00
 3939
    0.18213361E-01   0.18208535E-01   0.99973504E+00    0.14757774E-02   0.13532043E-02   0.91694341E+00
   -0.28679806E-04  -0.41731553E-04   0.14550849E+01    0.17374511E-05   0.16764975E-05   0.96491784E+00
   -0.96257755E-04  -0.14006320E-03   0.14550849E+01    0.19571838E-04   0.18885215E-04   0.96491784E+00
```

Sample Output File for Example 2 to UNIT 61

```
    gomex_g11_v019_s                    RUN GG4 - v24.16         gomex_g11_v018_s.grd
     2688           20   0.4500000E+03     5     1
   0.25924500000000000E+07       28805
 0.20801670E+00 0.10969408E+00 -.21817788E+00 0.35151306E-02 0.23963806E+00 0.16669705E+00 0.12280560E+00
                                                                 0.98741845E+01
0.21510405E+00 0.13150731E+00 0.23618745E+00 0.20810843E+00 0.19653960E+00 0.19011456E+00 0.17874381E+00 0.15438984E+00
 0.21409625E+00 0.26417815E+00 0.19356719E+00 0.20595057E+00
   0.25929000000000000E+07       28810
 0.22354005E+00 0.14516451E+00 -.23037181E+00 -.80757995E-02 0.24863054E+00 0.17704812E+00 0.13261599E+00
                                                                 0.10800240E+00
 0.22186596E+00 0.12977604E+00 0.23256599E+00 0.20876588E+00 0.19759601E+00 0.19037290E+00 0.17970085E+00
                                                                 0.14785973E+00
 0.21774676E+00 0.27429011E+00 0.19932352E+00 0.21710109E+00
   0.25933500000000000E+07       28815
 0.23870847E+00 0.18047041E+00 -.24112154E+00 -.18926462E-01 0.25732006E+00 0.18753539E+00 0.14249357E+00
                                                                 0.11733862E+00
 0.22845899E+00 0.12826893E+00 0.22865612E+00 0.20922438E+00 0.19860431E+00 0.19057960E+00 0.18072677E+00
                                                                 0.14157199E+00
 0.22126583E+00 0.28382929E+00 0.20494339E+00 0.22813539E+00
   0.25938000000000000E+07       28820
 0.25346930E+00 0.21546717E+00 -.25032914E+00 -.29024371E-01 0.26564484E+00 0.19812682E+00 0.15241934E+00
                                                                 0.12674210E+00
 0.23487895E+00 0.12702838E+00 0.22448535E+00 0.20949728E+00 0.19957429E+00 0.19075467E+00 0.18182137E+00
                                                                 0.13558565E+00
 0.22465328E+00 0.29276056E+00 0.21042151E+00 0.23902298E+00
   0.25942500000000000E+07       28825
 0.26777523E+00 0.25002258E+00 -.25788356E+00 -.38372248E-01 0.27357991E+00 0.20880382E+00 0.16237611E+00
                                                                 0.13620584E+00
 0.24111413E+00 0.12609592E+00 0.22008570E+00 0.20960367E+00 0.20051295E+00 0.19092218E+00 0.18298719E+00
                                                                 0.12995849E+00
 0.22790996E+00 0.30105099E+00 0.21574987E+00 0.24972878E+00
```

This portion of the output file has been eliminated

```
   0.37998000000000000E+07       42220
 0.17525110E+00 0.44423778E-01 -.20905916E+00 0.14260051E-01 0.21361222E+00 0.14295494E+00 0.10481117E+00 0.84913224E-
                                                                 01
 0.19313696E+00 0.12115614E+00 0.23253366E+00 0.19766702E+00 0.18620998E+00 0.18066589E+00 0.16775133E+00
                                                                 0.15208842E+00
 0.19930515E+00 0.23709156E+00 0.17541334E+00 0.17637063E+00
   0.38002500000000000E+07       42225
 0.19083182E+00 0.79236800E-01 -.22398912E+00 0.83266657E-03 0.22238375E+00 0.15256086E+00 0.11378554E+00 0.93228038E-
                                                                 01
 0.19955519E+00 0.11869119E+00 0.22867714E+00 0.19796788E+00 0.18676143E+00 0.18041745E+00 0.16810527E+00
                                                                 0.14487439E+00
 0.20251381E+00 0.24755620E+00 0.18078625E+00 0.18714295E+00
   0.38007000000000000E+07       42230
 0.20613468E+00 0.11416263E+00 -.23760112E+00 -.11923157E-01 0.23089238E+00 0.16233374E+00 0.12284406E+00
                                                                 0.10165504E+00
 0.20583951E+00 0.11641754E+00 0.22450974E+00 0.19805082E+00 0.18725929E+00 0.18009198E+00 0.16850731E+00
                                                                 0.13783418E+00
```

```
0.20559477E+00 0.25751194E+00 0.18604093E+00 0.19785349E+00
   0.38011500000000000E+07      42235
0.22111233E+00 0.14903509E+00 -.24981401E+00 -.23984279E-01 0.23910416E+00 0.17225733E+00 0.13196890E+00
                                                                 0.11019072E+00
0.21198108E+00 0.11437860E+00 0.22005767E+00 0.19792440E+00 0.18771617E+00 0.17971618E+00 0.16896075E+00
                                                                 0.13102784E+00
0.20855372E+00 0.26692335E+00 0.19117057E+00 0.20847401E+00
   0.38016000000000000E+07      42240
0.23571578E+00 0.18370244E+00 -.26053374E+00 -.35339297E-01 0.24702210E+00 0.18232375E+00 0.14115045E+00
                                                                 0.11882085E+00
0.21796846E+00 0.11261671E+00 0.21535133E+00 0.19760632E+00 0.18813718E+00 0.17931647E+00 0.16947003E+00
                                                                 0.12451415E+00
0.21139784E+00 0.27575639E+00 0.19616954E+00 0.21897741E+00
```

Sample Output File for Example 2 to UNIT 62

```
    gomex_g11_v019_s                  RUN GG4 - v24.16          gomex_g11_v018_s.grd
     1152           20    0.4500000E+03      5      2
   0.32836500000000000E+07      36485
-.19469754E+00 -.15726498E-01 -.18524458E+00 -.31327558E-01 -.18192519E+00 -.67991767E-01 -.62689021E-01
                                                                 0.73032240E-01
-.66285525E-01 -.10283921E-01 -.60279423E-01 0.17916693E-01 -.41653705E-01 0.11518033E-01 0.63127965E-04
                                                                 0.15820874E-01
0.31802979E-01 0.45756989E-02 0.36510010E-01 -.23843424E-01 0.35392334E-01 -.86682693E-02 0.50217752E-01
                                                                 -.15401588E-01
0.53134360E-01 -.12932885E-01 0.55501165E-01 -.23364983E-01 0.51096646E-01 -.17104916E-01 0.58106595E-01
                                                                 -.84033107E-01
0.42636931E-01 -.11193392E+00 0.23168856E-01 -.29048850E-01 0.92073950E 01 0.15891095E-01 -.53965910E-02
                                                                 -.44351075E-02

   0.32841000000000000E+07      36490
-.19347378E+00 -.15730906E-01 -.18392181E+00 -.31512988E-01 -.18074730E+00 -.67673593E-01 -.58504559E-01
                                                                 0.68302260E-01
-.62725548E-01 -.10291627E-01 -.57576092E-01 0.16173809E-01 -.37680662E-01 0.91645824E-02 0.24754613E-02
                                                                 0.12669070E-01
0.33283434E-01 -.61807935E-03 0.39289095E-01 -.31069231E-01 0.37533011E-01 -.11646847E-01 0.51959895E-01
                                                                 -.15839577E-01
0.55279672E-01 -.16817233E-01 0.55575951E-01 -.30644903E-01 0.50492378E-01 -.19067114E-01 0.58775079E-01
                                                                 -.93274518E-01
0.40979849E-01 -.12138089E+00 0.19279467E-01 -.31490834E-01 0.86551256E-01 0.11148143E-01 -.11796647E-01
                                                                 -.21890007E-01

   0.32845500000000000E+07      36495
-.19190790E+00 -.15699366E-01 -.18227691E+00 -.31631039E-01 -.17925244E+00 -.67225243E-01 -.54078268E-01
                                                                 0.63399709E-01
-.58926589E-01 -.10251957E-01 -.54678142E-01 0.14400891E-01 -.33486545E-01 0.67831273E-02 0.49413555E-02
                                                                 0.94847567E-02
0.34699431E-01 -.58502810E-02 0.41895811E-01 -.38212301E-01 0.39607144E-01 -.14598176E-01 0.53606209E-01
                                                                 -.16234847E-01
0.57310372E-01 -.20615556E-01 0.55493027E-01 -.37827483E-01 0.49763400E-01 -.20954956E-01 0.59186829E-01
                                                                 -.10198509E+00
0.39001156E-01 -.13016468E+00 0.15331799E-01 -.33785875E-01 0.80573772E-01 0.62041058E-02 -.18407374E-01
                                                                 -.39860638E-01
```

```
    0.3285000000000000E+07       36500
 -.18997955E+00 -.15631760E-01 -.18028941E+00 -.31677809E-01 -.17742091E+00 -.66633954E-01 -.49407898E-01
                                                                0.58342616E-01
 -.54890150E-01 -.10164407E-01 -.51584185E-01 0.12612899E-01 -.29094281E-01 0.43786445E-02 0.74538792E-02
                                                                0.62843098E-02
 0.36036201E-01 -.11092772E-01 0.44305967E-01 -.45220709E-01 0.41602289E-01 -.17511837E-01 0.55147712E-01
                                                                -.16578553E-01
 0.59212616E-01 -.24319567E-01 0.55241328E-01 -.44905552E-01 0.48909877E-01 -.22782798E-01 0.59372798E-01
                                                                -.11016668E+00
 0.36748500E-01 -.13829804E+00 0.11316782E-01 -.35940369E-01 0.74128783E-01 0.10676318E-02 -.25191754E-01
                                                                -.58238955E-01

    0.3285450000000000E+07       36505
 -.18766941E+00 -.15526515E-01 -.17793583E+00 -.31648192E-01 -.17523066E+00 -.65891529E-01 -.44495448E-01
                                                                0.53144388E-01
 -.50616293E-01 -.10038417E-01 -.48285712E-01 0.10834409E-01 -.24531311E-01 0.19613673E-02 0.99979380E-02
                                                                0.30870704E-02
 0.37275457E-01 -.16311265E-01 0.46522347E-01 -.52048127E-01 0.43513410E-01 -.20371696E-01 0.56564448E-01
                                                                -.16881841E-01
 0.60971558E-01 -.27922622E-01 0.54813518E-01 -.51883834E-01 0.47923269E-01 -.24562745E-01 0.59366677E-01
                                                                -.11784802E+00
 0.34259459E-01 -.14581885E+00 0.72219235E-02 -.37959318E-01 0.67184333E-01 -.42529091E-02 -.32106910E-01
                                                                -.76911616E-01
```

This portion of the input file has been eliminated

```
    0.3799800000000000E+07       42220
 -.11697163E+00 -.62274856E-02 -.11944349E+00 -.12070810E-01 -.11906512E+00 -.42913104E-01 -.11354582E+00
                                                                0.15105202E+00
 -.10263306E+00 -.16886696E-02 -.81129524E-01 0.54571758E-01 -.95719137E-01 0.66375601E-01 -.51427769E-01
                                                                0.87931407E-01
 -.58200440E-02 0.13608739E+00 -.39286343E-01 0.15148521E+00 -.13637189E-02 0.70026929E-01 0.48588404E-02
                                                                0.19484989E-02
 -.23069133E-01 0.11606130E+00 0.33309325E-01 0.19590311E+00 0.51046116E-01 0.59148324E-01 -.29537296E-01
                                                                0.23147308E+00
 -.18246145E-01 0.23227669E+00 0.11567510E+00 0.67335172E-01 0.13341183E+00 0.97285259E-01 0.10360971E+00
                                                                0.34511744E+00

    0.3800250000000000E+07       42225
 -.12007883E+00 -.64797577E-02 -.12235147E+00 -.12479546E-01 -.12190172E+00 -.43926103E-01 -.11524061E+00
                                                                0.15289610E+00
 -.10430277E+00 -.17400280E-02 -.82547607E-01 0.55496004E-01 -.97048623E-01 0.67348018E-01 -.51732335E-01
                                                                0.89246885E-01
 -.56590522E-02 0.13776313E+00 -.39659813E-01 0.15275517E+00 -.12520371E-02 0.70843510E-01 0.51232299E-02
                                                                0.19406420E-02
 -.23044408E-01 0.11711665E+00 0.34394202E-01 0.19734961E+00 0.51793827E-01 0.59601125E-01 -.29409196E-01
                                                                0.23289105E+00
 -.18283910E-01 0.23380034E+00 0.11696332E+00 0.67877372E-01 0.13503221E+00 0.98335313E-01 0.10464289E+00
                                                                0.34793528E+00

    0.3800700000000000E+07       42230
 -.12355473E+00 -.67734787E-02 -.12557809E+00 -.12968069E-01 -.12503313E+00 -.45061771E-01 -.11691140E+00
                                                                0.15461709E+00
 -.10594028E+00 -.18316155E-02 -.83963158E-01 0.56320376E-01 -.98283556E-01 0.68223908E-01 -.51989082E-01
                                                                0.90464946E-01
 -.54486775E-02 0.13929963E+00 -.39951618E-01 0.15382507E+00 -.11242914E-02 0.71578166E-01 0.54487689E-02
                                                                0.19028598E-02
 -.22881541E-01 0.11802776E+00 0.35519869E-01 0.19851807E+00 0.52571970E-01 0.59975437E-01 -.29140091E-01
                                                                0.23393951E+00
 -.18217831E-01 0.23492112E+00 0.11820505E+00 0.68323892E-01 0.13676164E+00 0.99403491E-01 0.10561823E+00
                                                                0.35051352E+00
```

```
  0.3801150000000000E+07      42235
-.12736337E+00 -.71065867E-02 -.12908895E+00 -.13537692E-01 -.12842863E+00 -.46315033E-01 -.11856042E+00
                                                            0.15621201E+00
-.10756274E+00 -.19602693E-02 -.85388057E-01 0.57044083E-01 -.99444346E-01 0.68990259E-01 -.52199170E-01
                                                            0.91559157E-01
-.51894257E-02 0.14065386E+00 -.40157477E-01 0.15465392E+00 -.96971249E-03 0.72198220E-01 0.58366857E-02
                                                            0.18298780E-02
-.22587819E-01 0.11875807E+00 0.36666845E-01 0.19937927E+00 0.53368628E-01 0.60245962E-01 -.28711462E-01
                                                            0.23456560E+00
-.18046108E-01 0.23560021E+00 0.11936832E+00 0.68632705E-01 0.13862559E+00 0.10047118E+00 0.10649857E+00
                                                            0.35285714E+00

  0.3801600000000000E+07      42240
-.13147176E+00 -.74766388E-02 -.13285107E+00 -.14187825E-01 -.13205797E+00 -.47677596E-01 -.12018916E+00
                                                            0.15767774E+00
-.10918462E+00 -.21220990E-02 -.86833721E-01 0.57674135E-01 -.10055196E+00 0.69635472E-01 -.52367463E-01
                                                            0.92510270E-01
-.48747528E-02 0.14178384E+00 -.40270744E-01 0.15521258E+00 -.77455749E-03 0.72674771E-01 0.62866452E-02
                                                            0.17211563E-02
-.22165223E-01 0.11927007E+00 0.37826065E-01 0.19990932E+00 0.54172708E-01 0.60382143E-01 -.28127002E-01
                                                            0.23472869E+00
-.17767993E-01 0.23580934E+00 0.12042983E+00 0.68774090E-01 0.14064041E+00 0.10151085E+00 0.10728327E+00
                                                            0.35498219E+00
```

Sample Output File for Example 2 to UNIT 63

```
gomex_g11_v019_s                RUN GG4 - v24.16           gomex_g11_v018_s.grd
96        3939   0.9000000E+03     10       1
 0.3456900000E+07            38410
     1    0.27907837E+00
     2    0.27909100E+00
     3    0.27917710E+00
     4    0.27908500E+00
     5    0.27925073E+00
     6    0.27929477E+00
     7    0.27925331E+00
     8    0.27939828E+00
     9    0.27911344E+00
    10    0.27945997E+00
```

A portion of the output has been eliminated here

```
 3930   -0.13732943E-01
 3931   -0.12638685E-01
 3932   -0.11699133E-01
 3933   -0.15571766E-01
 3934   -0.16374000E-01
 3935   -0.15194517E-01
 3936   -0.14918832E-01
 3937   -0.13704685E-01
 3938   -0.16204898E-01
 3939   -0.15624591E-01
 0.3457800000E+07            38420
```

```
         1   0.27807205E+00
         2   0.27813298E+00
         3   0.27812884E+00
         4   0.27798680E+00
         5   0.27828641E+00
         6   0.27823990E+00
         7   0.27803707E+00
         8   0.27820881E+00
         9   0.27789656E+00
        10   0.27845484E+00
```

A portion of the output has been eliminated here

```
      3930  -0.11025418E-01
      3931  -0.98905795E-02
      3932  -0.91168034E-02
      3933  -0.13299337E-01
      3934  -0.13815155E-01
      3935  -0.12364457E-01
      3936  -0.11988418E-01
      3937  -0.10876316E-01
      3938  -0.13365061E-01
      3939  -0.12672783E-01
      0.3458700000E+07          38430
         1   0.27679885E+00
         2   0.27688517E+00
         3   0.27683516E+00
         4   0.27665103E+00
         5   0.27703685E+00
         6   0.27695079E+00
         7   0.27662200E+00
         8   0.27683197E+00
         9   0.27646986E+00
        10   0.27719493E+00
```

The remainder of the output has been eliminated here

Sample Output File for Example 2 to UNIT 64

```
 gomex_g11_v019_s                 RUN GG4 - v24.16        gomex_g11_v018_s.grd
  96       3939   0.9000000E+03    10     2
   0.3456900000E+07          38410
       1   0.21355448E-02  -0.36130143E-02
       2   0.36576023E-02  -0.98479083E-03
       3   0.88232742E-03  -0.61426035E-03
       4   0.24140435E-02  -0.41032776E-02
       5   0.51562898E-02   0.24090557E-02
       6   0.12447554E-02   0.23626235E-02
       7   0.10466778E-02  -0.25682673E-03
       8  -0.70064066E-03   0.26210263E-02
       9   0.68922774E-03  -0.20510011E-02
      10   0.27492600E-02   0.69380707E-02
```

A portion of the output file has been eliminated here

```
3930  -0.64226247E-02   0.37133732E-02
3931   0.28480926E-03   0.21940447E-03
3932  -0.40391925E-02  -0.14137263E-03
3933  -0.10387975E-01   0.16883326E-02
3934  -0.11347101E-01   0.41825870E-02
3935  -0.60537632E-02   0.24546561E-02
3936   0.15770581E-02   0.17392762E-02
3937   0.16960456E-02   0.22237193E-02
3938  -0.33933043E-02   0.59848354E-02
3939   0.97314066E-03   0.32661425E-02
0.3457800000E+07          38420
   1   0.21388124E-02  -0.36185425E-02
   2   0.36774779E-02  -0.99014223E-03
   3   0.88848773E-03  -0.66060301E-03
   4   0.24379326E-02  -0.41438831E-02
   5   0.51017453E-02   0.23835721E-02
   6   0.12239134E-02   0.22250479E-02
   7   0.10581646E-02  -0.35948749E-03
   8  -0.71530274E-03   0.25524220E-02
   9   0.70971814E-03  -0.21119763E-02
  10   0.26846672E-02   0.67750635E-02
```

A portion of the output file has been eliminated here

```
3930  -0.63525062E-02   0.35020050E-02
3931  -0.11198967E-03  -0.86271898E-04
3932  -0.43258551E-02  -0.15140589E-03
3933  -0.10401049E-01   0.16904576E-02
3934  -0.11004690E-01   0.40563729E-02
3935  -0.59296920E-02   0.21990130E-02
3936   0.12487210E-02   0.13771659E-02
3937   0.13006010E-02   0.17052441E-02
3938  -0.30584609E-02   0.53942658E-02
3939   0.83315901E-03   0.27963235E-02
0.3458700000E+07          38430
   1   0.20032661E-02  -0.33892190E-02
   2   0.35740620E-02  -0.96229803E-03
   3   0.79888947E-03  -0.39895900E-03
   4   0.22741429E-02  -0.38654811E-02
   5   0.50795711E-02   0.23732122E-02
   6   0.11421270E-02   0.24017518E-02
   7   0.96247524E-03  -0.24928462E-04
   8  -0.80785612E-03   0.29311696E-02
   9   0.59100336E-03  -0.17587054E-02
  10   0.27050958E-02   0.68266174E-02
```

The remainder of the output file has been eliminated here

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13. ABSTRACT *(Maximum 200 words)*
This report describes the use of model ADCIRC-2DDI, a two-dimensional, depth-integrated, finite-element-based hydrodynamic circulation code. ADCIRC-2DDI solves the shallow-water equations in their full nonlinear form and can be forced with elevation boundary conditions, zero normal boundary fluxes, variable spatial and temporal free surface stress and atmospheric pressure forcing functions in addition to Coriolis and tidal potential forcing terms.

The algorithms that comprise ADCIRC-2DDI allow for extremely flexible spatial discretizations, which results in a highly effective minimization of the discrete size of any problem. Furthermore, these algorithms show good stability characteristics, generate no spurious artificial modes, have no inherent artificial damping, and are extremely efficient. The resulting model can be applied to computational domains ranging from the deep ocean to estuaries. Furthermore, the model is able to efficiently run months to years of simulation while providing detailed intratidal response characteristics.

A compete description of all user aspects is given in this document, including code setup and a description of all input and output files. Both model-specific and general modeling practices are discussed. Finally, two examples are presented. Sample input and output files for these examples are included in Appendices A and B.

14. SUBJECT TERMS

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